

PROPARGYLAMINO INDA DERIVATIVES AND PROPARGYLAMINO
TETRALIN DERIVATIVES AS BRAIN-SELECTIVE MAO INHIBITORS

This application claims the benefit of U.S. Serial No. 5 10/085,674, filed February 27, 2002, the contents of which are hereby incorporated by reference.

Throughout this application, various references are referenced by short citations within parenthesis. Full citations for these 10 references may be found at the end of the specification, immediately preceding the claims. These references, in their entireties, are hereby incorporated by reference to more fully describe the state of the art to which this invention pertains.

15 Field of the Invention

The subject of this invention provides for derivatives of propargylaminoindans and propargylaminotetralins that are irreversible inhibitors of the enzyme monoamine oxidase A and/or 20 B and also for prodrugs for the administration of these compounds. Such compounds may be useful in the treatment of Parkinson's disease, Alzheimer's disease, depression and other neurological disorders.

25 Background of the Invention

The enzyme monoamine oxidase (MAO) plays an essential role in the metabolic degradation of important amine neurotransmitters including dopamine, serotonin and noradrenaline. Thus, agents 30 that inhibit MAO are of potential therapeutic benefit for a variety of neurological disease indications, including Parkinson's disease, Alzheimer's disease, depression, epilepsy, narcolepsy, amyotrophic lateral sclerosis (ALS), etc. (Szelnyi, I.; Bentue-Ferrer et al.; Loscher et al.; White et al.; U.S. 35 Patent No. 5,744,500). Other diseases and conditions which have

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been associated with toxic levels of monoamine oxidase-B are memory disorders (The interaction of L-deprenyl and scopolamine on spatial learning/memory in rats), panic, post-traumatic stress disorder (PTSD), sexual dysfunction, attention deficit and hyperactivity syndrome (ADHD) (Potential applications for monoamine oxidase B inhibitors), attention deficit disorder (Kleywegt), and Tourette's syndrome (Treatment of Tourette's: Overview).

10 Many inhibitors of MAO are chiral molecules (U.S. Patent No. 5,744,500). Although one enantiomer often shows some stereoselectivity in relative potency towards MAO-A and -B, a given enantiomeric configuration is not always more selective than its isomer in discriminating between MAO-A and -B
15 (Hazelhoff et al., Naunyn-Schmeideberg's Arch. Pharmacol.).

MAO inhibitors can also be classified as reversible inhibitors which inhibit the enzyme by a competitive mechanism or as irreversible inhibitors which are generally mechanism based
20 (suicide inhibitors) (Dostert). For example, moclobemide is a reversible MAO-A-specific inhibitor (Fitton et al.) developed as an anti-depressant. Likewise, rasagiline (U.S. Patent No. 5,744,500) and selegiline (Chrisp et al.) are MAO-B-selective irreversible inhibitors.

25 Irreversible inhibitors have the advantage of lower, less frequent dosing since their MAO inhibition is not based directly on the drugs' pharmacokinetic behavior, but rather on the *de novo* regeneration of the MAO enzyme.

30 MAO also plays an essential role in the oxidative deamination of biogenic and food-derived amines, both in the central nervous system and in peripheral tissues. MAO is found in two functional isoenzyme forms, MAO-A and MAO-B, each of which shows
35 preferential affinity for substrates and specificity toward

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inhibitors. Thus, MAO-A preferentially oxidizes serotonin, noradrenaline and adrenaline, whereas MAO-B preferentially metabolizes phenylethylamine. Dopamine is a substrate for both forms of the enzyme (Szelenyi, I.).

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N-Propargyl-(1R)-aminoindan is known to be a potent B-selective inhibitor of MAO (U.S. Patent No. 5,457,133). Various derivatives of this compound have been prepared and shown to have varying degrees of potency and selectivity for the inhibition of MAO-A and/or -B. There is no currently accepted theory explaining the effect of structure on the activity (SAR) of the various substituted propargylaminoindans.

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The dopamine agonistic activity and MAO inhibitory properties of 7-(methyl-prop-2-ynylamino)-tetalin-2-ol and 7-(methyl-prop-2-ynylamino)-tetalin-2,3-diol have been reported (Hazelhoff et al., Eur. J. Pharmacol.). The details of the synthesis of these compounds have not been published, however.

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6,7-di-O-benzoyl-2-aminotetalin has been reported as a prodrug of the dopaminergic agonist 6,7-di-hydroxy-2-aminotetalin (Horn et al.). However, no N-propargyl derivatives were reported and the compounds were not shown to have MAO inhibitory or neuroprotective activities.

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7-(propyl-prop-2-ynylamino)-tetalin-2-ol has been reported as an intermediate in the preparation of 7-[(3-iodoallyl)-propylamino]-tetalin-2-ol. Only the latter has been pharmacologically characterized as D₃-dopamine receptor ligand (Chumpradit et al.). No other N-alkyl substituents were described.

Florvall et al. report the preparation of amino acid-based prodrugs of amiflamine analogues. Amiflamine is a reversible MAO-A inhibitor.

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PCT International Application No. PCT/US97/24155 concerns carbamate aminoindan derivatives, including propargylamines, as inhibitors of MAO-A and MAO-B for the treatment of Alzheimer's disease and other neurological conditions. However, the 5 compounds of PCT/US97/24155 are not selective for MAO over acetylcholinesterase ("AChE"). Thus, the compounds generally inhibit acetylcholinesterase along with MAO. Acetylcholinesterase inhibition is a route implicated in certain neurological disorders, but is a different route from the route 10 of MAO inhibition.

U.S. Patent No. 6,303,650 discloses derivatives of 1-aminoindan as selective MAO B inhibitors that additionally inhibit acetylcholinesterase. The reference teaches that its compounds 15 can be used to treat depression, Attention Deficit Disorder (ADD), Attention Deficit and Hyperactivity Disorder (ADHD), Tourette's Syndrome, Alzheimer's Disease and other dementias such as senile dementia, dementia of the Parkinson's type, vascular dementia and Lewy body dementia.

20 Many irreversible MAO inhibitors contain the propargyl amine functionality. This pharmacophore is responsible for the MAO inhibitory activity of such compounds. Some propargylamines have been shown to have neuroprotective/neurorescue properties 25 independent of their MAO inhibition activity (U.S. Patent No. 4,844,033; Krageten et al.).

PCT International Application No. PCT/IL96/00115 relates to pharmaceutical compositions comprising racemic, (S), and (R)-N-30 propargyl-1-aminoindan. (R)-N-propargyl-1-aminoindan selectively inhibits MAO-B in the treatment of Parkinson's disease and other neurological disorders (PCT/IL96/00115).

35 Derivatives of 1-aminoindan, including propargyl aminoindan, and their salts are described in many U.S. patents (U.S. Patents No.

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5,639,913, 5,877,221, 5,880,159, 5,877,218, 5,914,349, 5,994,408) and a PCT International Application (PCT/US95/00245). These references disclose racemic, R and S enantiomers of 1-aminoindan derivatives for the treatment of Parkinson's disease 5 and other neurological conditions (U.S. Patents No. 5,639,913, 5,877,221, 5,880,159, 5,877,218, 5,914,349, 5,994,408, PCT/US95/00245).

PCT International Application No. PCT/US97/24155 concerns 10 aminoindan derivatives, including propargyl aminoindan, as inhibitors of MAO-A and MAO-B for the treatment of Parkinson's disease and other neurological conditions. The publication reveals that the disclosed compounds exhibit a greater 15 selectivity for MAO-A and MAO-B in the brain than in the liver or intestine.

U.S. Patent No. 6,316,504 discloses that the R(+) enantiomer 20 of N-propargyl-1-aminoindan is a selective irreversible inhibitor of MAO-B. The patent indicates that (R)-N-propargyl-1-aminoindan is useful for the treatment of Parkinson's disease, a memory disorder, dementia, depression, hyperactive syndrome, an affective illness, a neurodegenerative disease, a neurotoxic injury, stroke, brain ischemia, a head trauma injury, a spinal trauma injury, neurotrauma, 25 schizophrenia, an attention deficit disorder, multiple sclerosis, and withdrawal symptoms.

European Patent No. 436492 discloses the R enantiomer of N-propargyl-1-aminoindan as a selective irreversible inhibitor of 30 MAO-B in the treatment of Parkinson's disease and other neurological conditions. Numerous U.S. patents also relate to the MAO B inhibition of (R)-N-propargyl-1-aminoindan and its use for treating patients suffering from Parkinson's Disease and other neurological disorders (U.S. Patents No. 5,387,612, 35 5,453,446, 5,457,133, 5,519,061, 5,532,415, 5,576,353,

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5,668,181, 5,744,500, 5,786,390 and 5,891,923).

5 PCT International Application No. PCT/IL97/00205 discloses S-
(-)-N-propargyl-1-aminooindan or a pharmaceutically acceptable
salt thereof for the treatment of a neurological disorder of
neurotrauma or for improving memory. The compounds were found
to be neuroprotective, but not inhibitory of MAO-A or MAO-B
(PCT/IL97/00205).

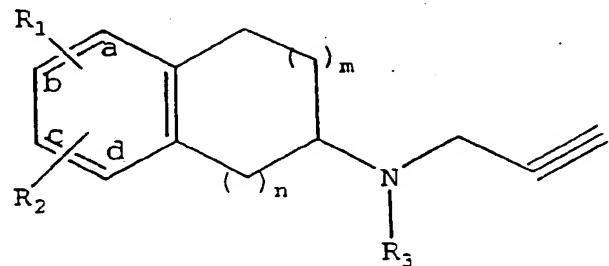
10 10 U.S. Patent No. 5,486,541 provides N-propargyl-1-aminooindan
monofluorinated in the phenyl ring as selective inhibitors of
MAO-B. These compounds are presented as useful in the treatment
of Parkinson's disease, memory disorders, dementia of the
15 Alzheimer's type, depression and the hyperactive syndrome in
children.

20 Among the many derivatives of propargylaminoindan mentioned in
the prior art are hydroxy-propargylaminoindans. U.S. Patent No.
3,513,244 lists some racemic N-propargylamino indanols and
tetralinols for use as antihypertensives. These compounds are
not exemplified chemically and are not pharmacologically
characterized (U.S. Patent No. 3,513,244).

25 25 N-propargylamino indanol also appears in E.P. 267024 as a
hydrofluorene derivative, i.e., 3-amino-4-indanol (7-OH
fluorene). The hydrofluorene derivatives and salts in E.P.
267024 are employed as cerebral activators in the treatment of
anoxemia and hypoxemia. In addition, such derivatives help
30 prevent arrhythmia and heart failure caused by lack of oxygen
(E.P. 267024). The derivatives also act as antioxidants and
cholinergic nerve system activating agents (E.P. 267024).

Summary of the Invention

The subject invention provides a compound having the structure:



wherein R_1 is $OC(O)R_2$ and R_2 is H.

wherein R₉ is branched or unbranched C₁ to C₆ alkyl, aryl, or aralkyl, or

R_1 is $OC(O)R_4$ and R_2 is $OC(O)R_4$.

wherein R_4 is branched or unbranched C_1 to C_6 alkyl, aryl, aralkyl or NR_5R_6 ,

wherein R_5 and R_6 are each independently H, C₁ to C₈ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

wherein R₃ is H or C₁ to C₆ alkyl;

wherein n is 0 or 1; and

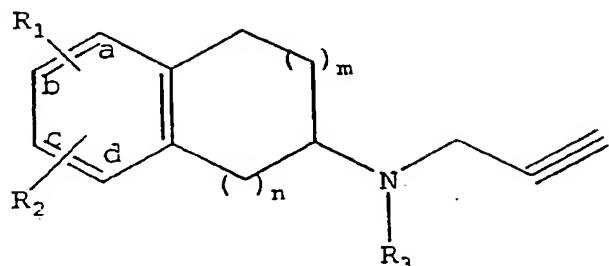
wherein m is 1 or 2,

or a pharmaceutically acceptable salt thereof.

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The subject invention also provides a compound having the structure:



wherein R₁ is OH;

wherein R₂ is H or OC(O)R₄ when R₁ is attached to the "a" carbon or the "d" carbon, or

15 R₂ is OC(O)R₄ when R₁ is attached to the "b" carbon or the "c" carbon;

wherein R₄ is C₁ to C₆ branched or unbranched alkyl, aryl, aralkyl or NR₅R₆,

wherein R₅ and R₆ are each independently H, C₁ to C₆ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

20 wherein n is 0 or 1, and m is 1 or 2; and

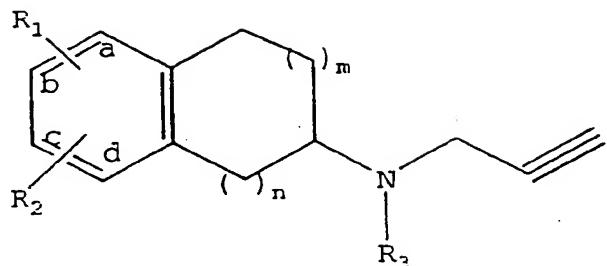
wherein R₃ is H or Me when n is 1 and m is 1, or R₃ is H or C₁ to C₆ alkyl when n is 0 or m is 2,

or a pharmaceutically acceptable salt thereof.

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In addition, the subject invention provides a compound having the structure:



wherein the compound is an optically pure enantiomer;

wherein R₁ is OH;

wherein R₂ is H;

wherein R₃ is H or C₁ to C₆ alkyl;

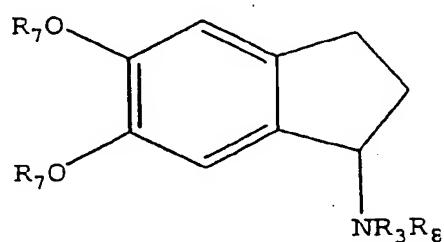
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wherein n is 0 or 1; and

wherein m is 1 or 2,

or a pharmaceutically acceptable salt thereof.

20 The subject invention further provides a compound having the structure:



wherein R₇ is H, C₁ to C₆ alkyl, aryl, aralkyl or C(O)R₄,

wherein R₄ is branched or unbranched C₁ to C₆ alkyl, aryl, aralkyl or NR₅R₆,

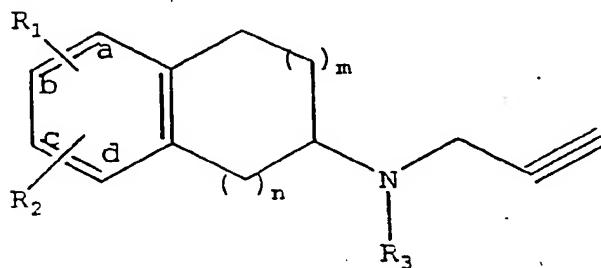
30 wherein R₅ and R₆ are each independently H, C₁ to C₈ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

wherein R₃ is H or C₁ to C₆ alkyl;

wherein R₈ is H or t-butoxycarbonyl (Boc).

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The subject invention also provides a method of treating a subject afflicted with a neurological disease comprising administering to the subject a compound having the structure:



wherein R₁ is OH or OC(O)R₉, and wherein R₉ is branched or unbranched C₁ to C₆ alkyl, aryl, or aralkyl;

15 R₂ is H or OC(O)R₄, or both R₁ and R₂ are OC(O)R₄,

wherein R₄ is branched or unbranched C₁ to C₆ alkyl, aryl, aralkyl or NR₅R₆,

wherein R₅ and R₆ are each independently H, C₁ to C₆ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

20 wherein R₃ is H or C₁ to C₆ alkyl;

wherein n is 0 or 1; and

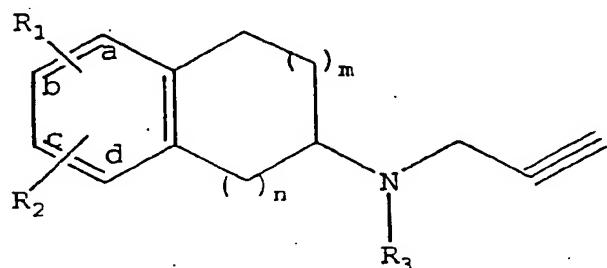
wherein m is 1 or 2,

or a pharmaceutically acceptable salt thereof, or a prodrug which becomes the compound in the subject, so as to thereby 25 treat the neurological disease in the subject.

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Furthermore, the subject invention provides a method of treating a subject afflicted with a neurological disease comprising administering to the subject a compound having the structure:

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wherein R_1 is OH or $OC(O)R_4$;

wherein R_2 is H or $OC(O)R_4$.

15

wherein R₄ is branched or unbranched C₁ to C₆ alkyl, aryl, aralkyl or NR₅R₆,

wherein R_5 and R_6 are each independently H, C_1 to C_8 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to C_{12} cycloalkyl, each optionally substituted;

20

wherein R₂ is H or C₁ to C₆ alkyl;

wherein n is 0 or 1; and

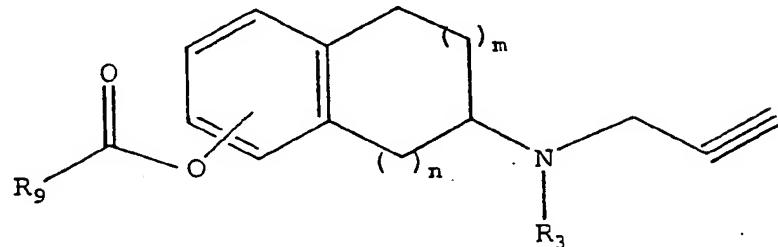
wherein m is 1 or 2.

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or a pharmaceutically acceptable salt thereof, or a prodrug which becomes the compound in the subject, so as to thereby treat the neurological disease in the subject.

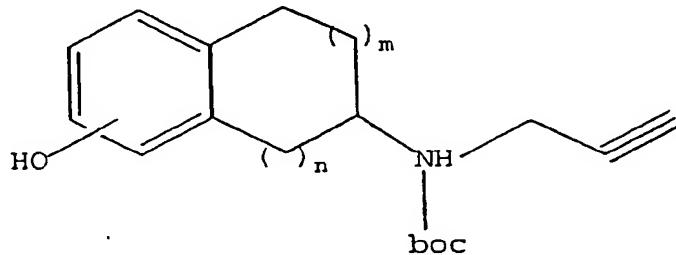
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The subject invention additionally provides a process for preparing a compound having the structure:

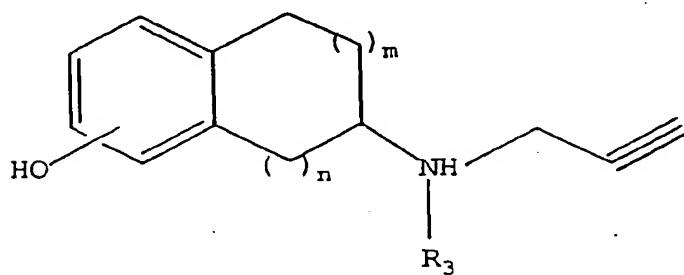


wherein n is 0 or 1, and m is 1 or 2;
 10 wherein R₃ is H or C₁ to C₆ alkyl; and
 wherein R₉ is branched or unbranched C₁ to C₆ alkyl,
 aryl, or aralkyl;

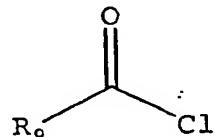
comprising the step of reacting



20 or



30 with

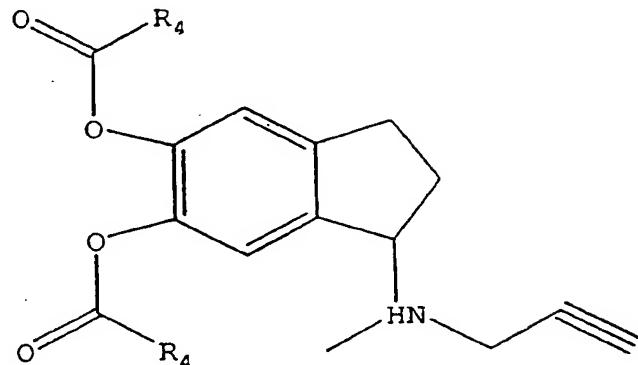


35 in the presence of an acid or 4-dimethylaminopyridine (DMAP) to form the compound.

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The subject invention also provides a process for preparing a compound having the structure:

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15 wherein R_4 is branched or unbranched C_1 to C_6 alkyl, aryl, aralkyl or NR_5R_6 ,

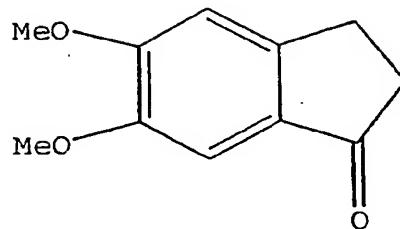
wherein R_5 and R_6 are each independently H, C_1 to C_6 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to C_{12} cycloalkyl, each optionally substituted;

20 which process comprises:

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(a) reacting a compound having the structure:

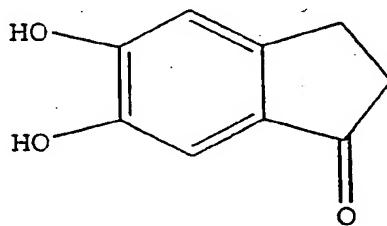
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with AlCl_3 or BBr_3 in the presence of toluene to produce a compound having the structure:

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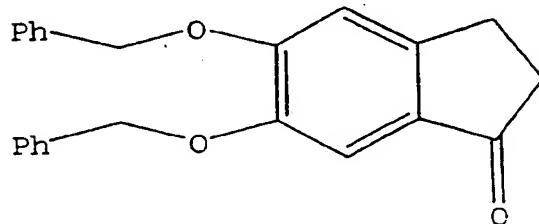


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(b) reacting the product formed in step (a) with benzyl chloride and K_2CO_3 in the presence of dimethyl formamide (DMF) to produce a compound having the structure:

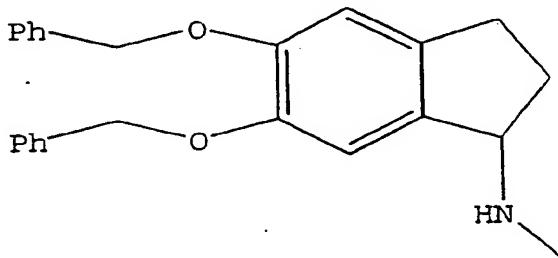
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(c) reacting the product formed in step (b) with $MeNH_2 \cdot HCl$, $NaCNBH_3$, in tetrahydrofuran (THF)/MeOH to produce a compound having the structure:

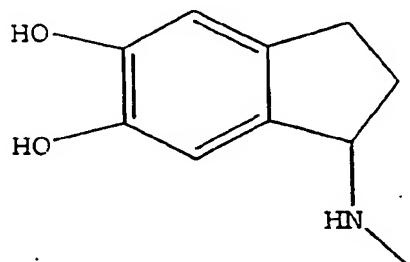
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25 (d) reacting the product formed in step (c) with H_2 , Pd/C and MeOH to produce a compound having the structure:

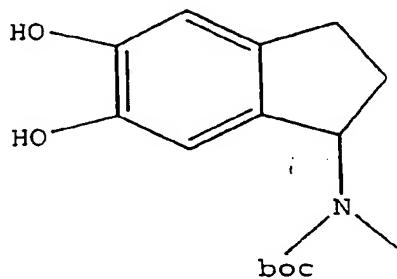
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(e) reacting the product formed in step (d) with Boc_2O , dioxane/ H_2O and NaHCO_3 to produce a compound having the structure:

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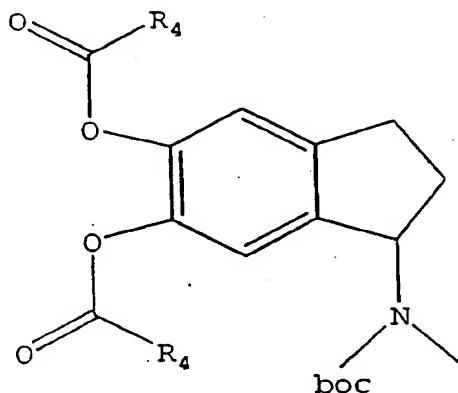
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(f) reacting the product formed in step (e) with R_4COCl , Et_3N in CH_2Cl_2 in the presence of 4-dimethylaminopyridine (DMAP) to produce a compound having the structure:

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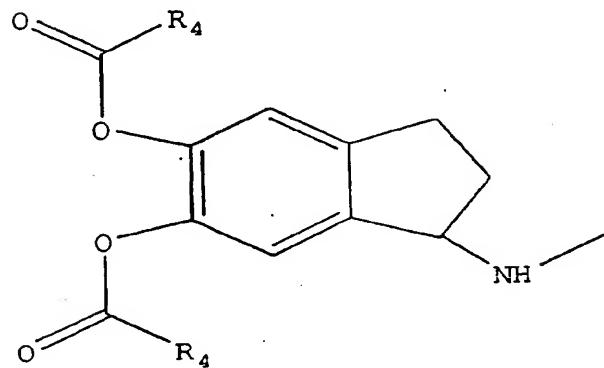
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(g) reacting the product formed in step (f) with HCl/dioxane to produce a compound having the structure:

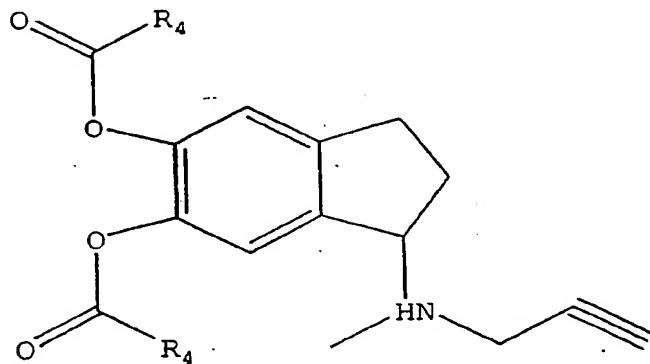
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15 (h) reacting the product formed in step (g) with propargyl bromide, K₂CO₃ in CH₃CN and then with HCl/ether and MeOH to produce a compound having the structure:

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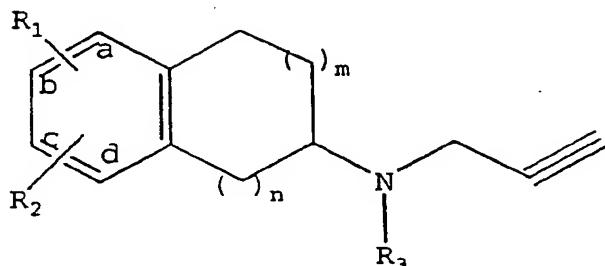
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The subject invention also provides the use of a compound or a prodrug of a compound which becomes the compound having the structure:

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wherein R₁ is OH or OC(O)R₄;

wherein R₂ is H, OH or OC(O)R₄,

wherein R₄ is branched or unbranched C₁ to C₆ alkyl,
15 aryl, aralkyl or NR₅R₆,

wherein R₅ and R₆ are each independently H, C₁ to
C₈ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to
C₁₂ cycloalkyl, each optionally substituted;

wherein R₃ is H or C₁ to C₆ alkyl;

20 wherein n is 0 or 1; and

wherein m is 1 or 2,

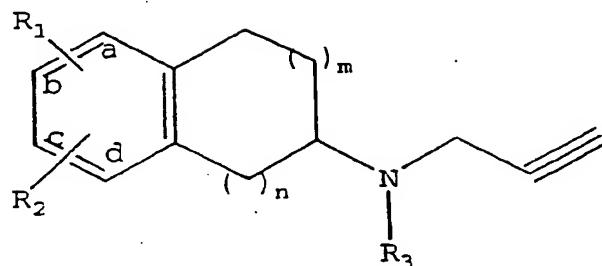
or a pharmaceutically acceptable salt thereof,

for the manufacture of a medicament for treating a subject
afflicted with a neurological disease, wherein the compound
25 is to be periodically administered to the subject in a
therapeutically effective dose.

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Additionally, the subject invention provides the use of a compound or a prodrug of a compound which becomes the compound having the structure:

5



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wherein R₁ is OH or OC(O)R₉, and

wherein R₉ is branched or unbranched C₁ to C₆ alkyl,
aryl, or aralkyl;

15

R₂ is H or OC(O)R₄, or both R₁ and R₂ are OC(O)R₄,

wherein R₄ is C₁ to C₆ alkyl, aryl, aralkyl or NR₅R₆,

wherein R₅ and R₆ are each independently H, C₁ to
C₈ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to
C₁₂ cycloalkyl, each optionally substituted;

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wherein R₃ is H or C₁ to C₆ alkyl;

wherein n is 0 or 1; and

wherein m is 1 or 2,

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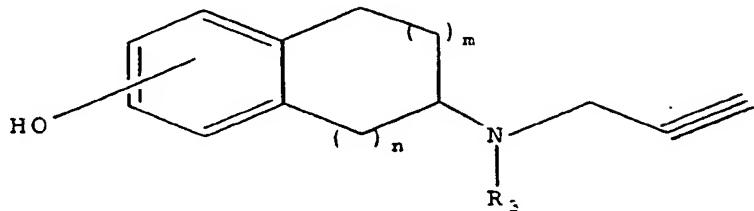
or a pharmaceutically acceptable salt thereof, for the
manufacture of a medicament for treating neurological
disease in a subject, wherein the compound is to be
periodically administered to the subject in a
therapeutically effective dose.

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Description of the Drawings

Figure 1 presents routes for the manufacture of compounds with the following structures:

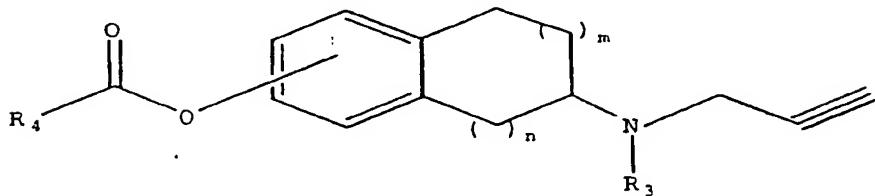
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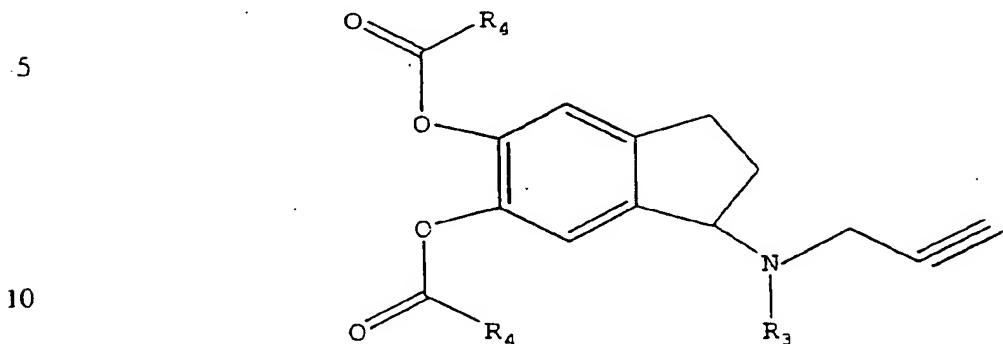
and

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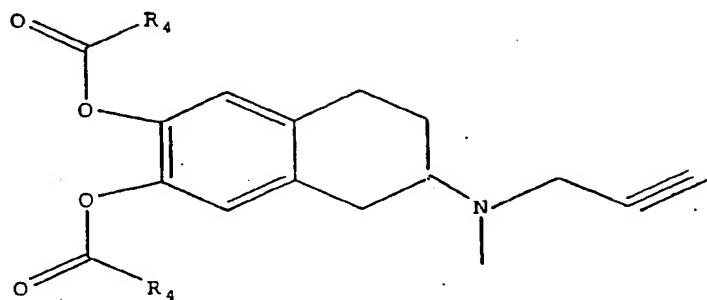
Figure 2 displays routes for the manufacture of a compound with the following structure:



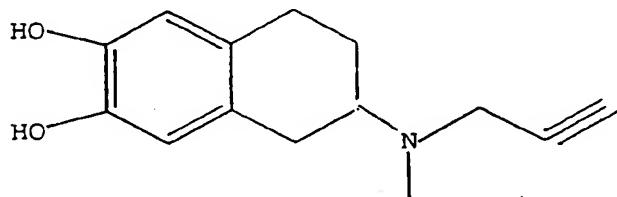
15 In Figure 2, the letters a) - i) are used to designate the following: a) AlCl_3 , toluene; b) BnCl , K_2CO_3 , DMF; c) $\text{R}_3\text{-NH}_2$, HCl , NaCNBH_3 , THF/MeOH; d) H_2 , Pd/C , MeOH; e) Boc_2O , dioxane/ H_2O , NaHCO_3 ; f) $\text{R}_4\text{-COCl}$, Et_3N , DMAP, CH_2Cl_2 ; g) HCl /dioxane; h) propargyl bromide, K_2CO_3 , CH_3CN ; and i) HCl /ether, MeOH.

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Figure 3 depicts routes for the manufacture of compounds with the structures:



and

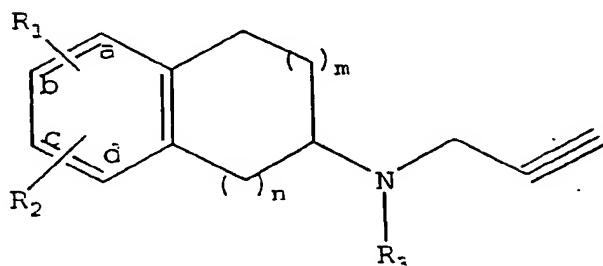


In Figure 3, the letters g) - l) are used to designate the following: g) NaCNBH₃, NH₄OAc; h) propargyl bromide, ACN, K₂CO₃; i) NaCNBH₃, paraformaldehyde; j) N-methylpropargylamine, NaCNBH₃; k) BBr₃; and l) R₄COCl, TFA or DMAP.

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Detailed Description of the Invention

The subject invention provides a compound having the structure:



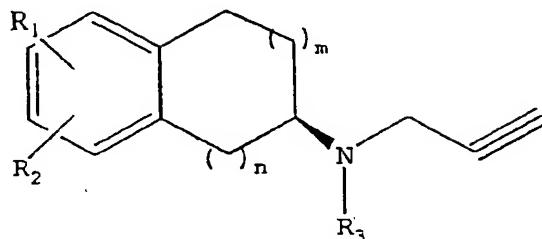
10 wherein R₁ is OC(O)R₉ and R₂ is H,
 wherein R₉ is branched or unbranched C₁ to C₆ alkyl,
 aryl, or aralkyl, or
 R₁ is OC(O)R₄ and R₂ is OC(O)R₄,
 wherein R₄ is branched or unbranched C₁ to C₆ alkyl,
 15 aryl, aralkyl or NR₅R₆,
 wherein R₅ and R₆ are each independently H, C₁ to
 C₈ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to
 C₁₂ cycloalkyl, each optionally substituted;
 wherein R₃ is H or C₁ to C₆ alkyl;
 20 wherein n is 0 or 1; and
 wherein m is 1 or 2,
 or a pharmaceutically acceptable salt thereof.

25 In one embodiment, the pharmaceutically acceptable salt is the acetate salt, mesylate salt, esylate, tartarate salt, hydrogen tartarate salt, benzoate salt, phenylbutyrate salt, phosphate salt, citrate salt, ascorbate salt, mandelate salt, adipate salt, octanoate salt, the myristate salt, the succinate salt, or fumarate salt.

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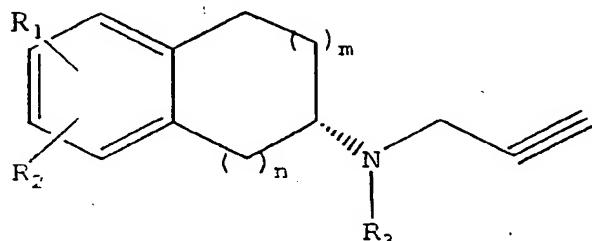
In another embodiment, the compound has the structure:

5



10 In a further embodiment, the compound has the structure:

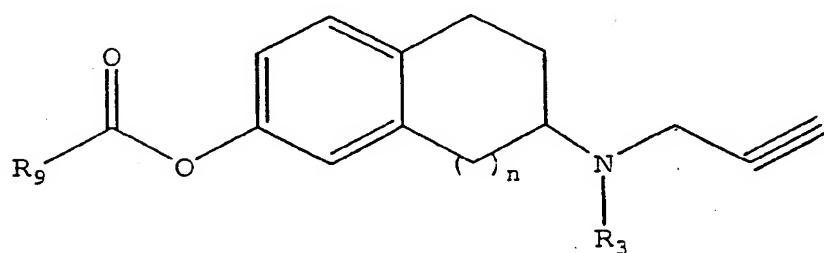
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20

In yet another embodiment, the compound has the structure:

25



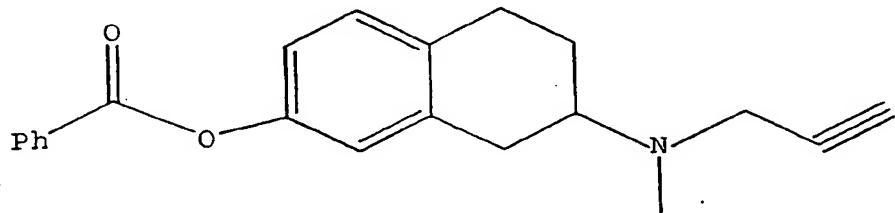
30

In one embodiment, n is 1.

-25-

In a further embodiment, the compound has the structure:

5

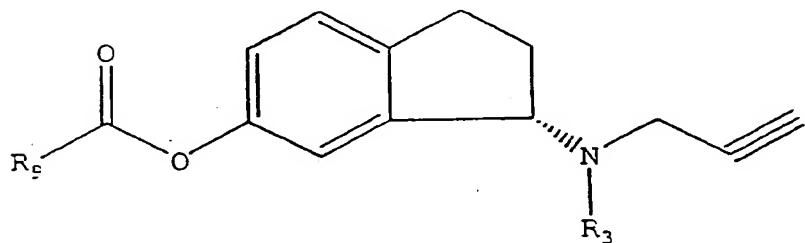


In an added embodiment, n is 0.

10

In yet another embodiment, the compound has the structure:

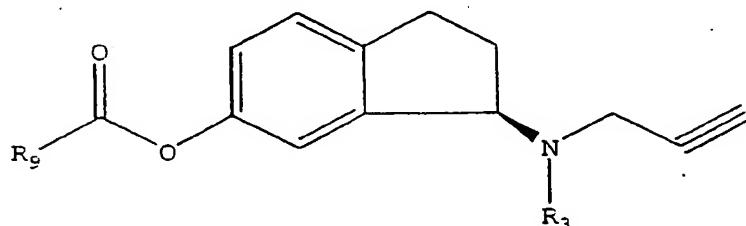
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20

In still another embodiment, the compound has the structure:

25



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In one embodiment, R_9 is Me and R_3 is H.

In another embodiment, R_9 is tBu and R_3 is H.

In a further embodiment, R_9 is nBu and R_3 is H.

5

In yet another embodiment, R_9 is CH_2Ph and R_3 is H.

In an additional embodiment, R_9 is Ph and R_3 is H.

10 In still another embodiment, wherein R_9 is Me and R_3 is Me.

In a further embodiment, R_9 is nBu and R_3 is Me.

In one embodiment, R_9 is Ph and R_3 is Me.

15

In an added embodiment, R_9 is tBu and R_3 is Me.

In another embodiment, R_9 is $Ph(Me)$ and R_3 is Me.

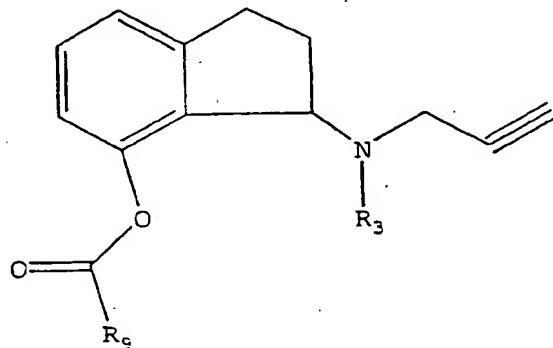
20 In still another embodiment, R_9 is $Ph(OMe)_2$ and R_3 is Me.

In a further embodiment, R_9 is $Ph(OMe)_2$ and R_3 is H.

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In one embodiment, the compound has the structure:

5



10

In an additional embodiment, R₃ is Me and R₉ is Me.

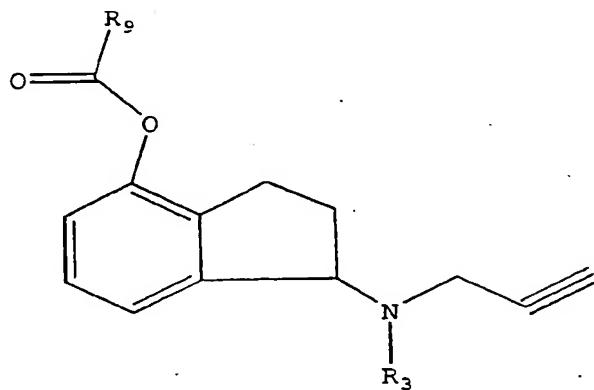
In a further embodiment, R₃ is Me and R₉ is Ph.

15

In another embodiment, R₃ is Me and R₉ is Ph(OMe)₂.

In yet another embodiment, the compound has the structure:

20



25

In an added embodiment, R₃ is Me and R₉ is Me.

30

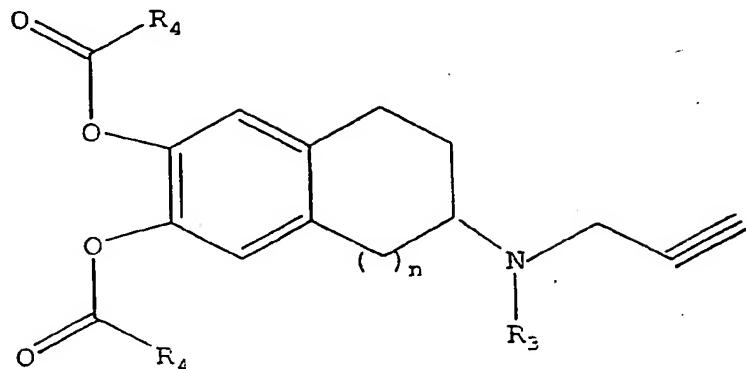
In still another embodiment, R₃ is H and R₉ is Ph.

In one embodiment, R₃ is H and R₉ is Ph(OMe)₂.

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In another embodiment, the compound has the structure:

5



10

In a further embodiment, n is 0.

15 In yet another embodiment, R₄ is Ph and R₃ is Me.

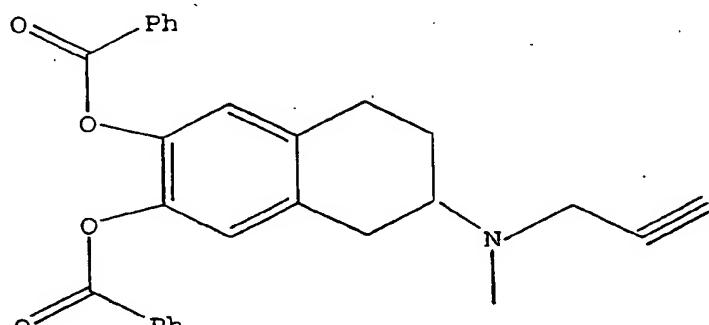
In one embodiment, n is 1.

In still another embodiment, R₃ is Me.

20

In an added embodiment, the compound has the structure:

25

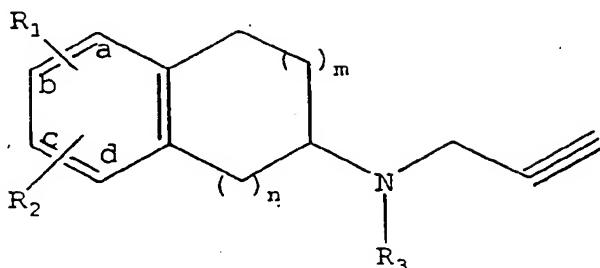


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The subject invention also provides a compound having the structure:

5



wherein R₁ is OH;

10 wherein R₂ is H or OC(O)R₄ when R₁ is attached to the "a" carbon or the "d" carbon, or

R₂ is OC(O)R₄ when R₁ is attached to the "b" carbon or the "c" carbon;

wherein R₄ is C₁ to C₆ branched or unbranched alkyl, 15 aryl, aralkyl or NR₅R₆,

wherein R₅ and R₆ are each independently H, C₁ to C₆ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

wherein n is 0 or 1, and m is 1 or 2; and

20 wherein R₃ is H or Me when n is 1 and m is 1, or R₃ is H or C₁ to C₆ alkyl when n is 0 or m is 2, or a pharmaceutically acceptable salt thereof.

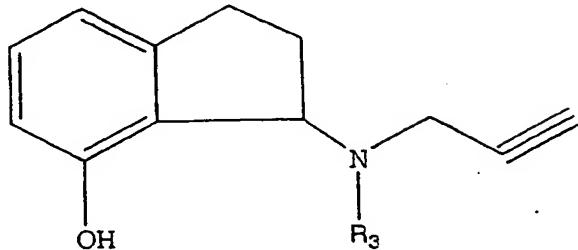
In one embodiment, the pharmaceutically acceptable salt is the 25 acetate salt, mesylate salt, esylate, tartarate salt, hydrogen tartarate salt, benzoate salt, phenylbutyrate salt, phosphate salt, citrate salt, ascorbate salt, mandelate salt, adipate salt, octanoate salt, the myristate salt, the succinate salt, or fumarate salt.

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-30-

In another embodiment, the compound has the structure:

5



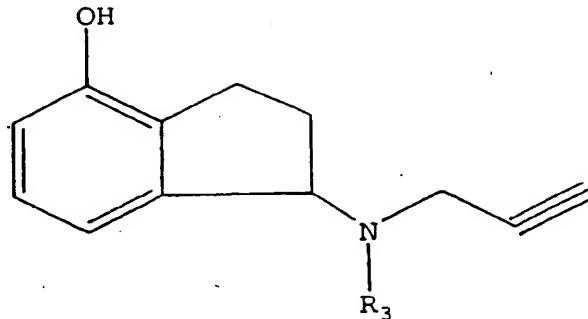
10 In an additional embodiment, R₃ is H.

In a further embodiment, R₃ is Me.

In yet another embodiment, the compound has the structure:

15

20



25 In still another embodiment, R₃ is H.

In one embodiment, R₃ is Me.

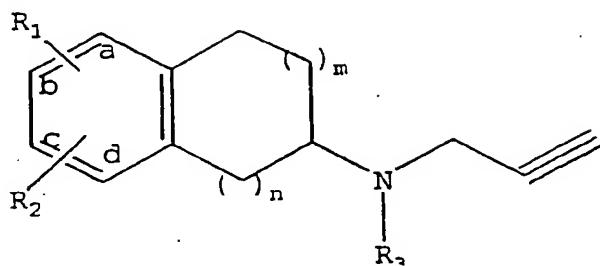
In a further embodiment, n is 0.

30

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Additionally, the subject invention provides a compound having the structure:

5



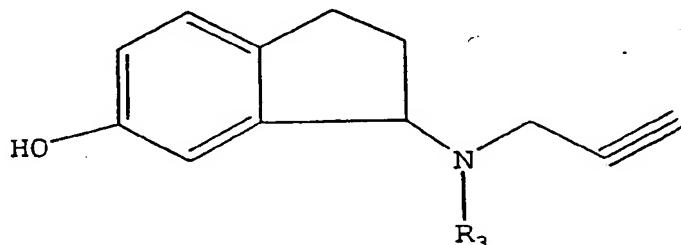
wherein the compound is an optically pure enantiomer;
 10 wherein R₁ is OH;
 wherein R₂ is H;
 wherein R₃ is H or C₁ to C₆ alkyl;
 wherein n is 0 or 1; and
 wherein m is 1 or 2,
 15 or a pharmaceutically acceptable salt thereof.

In one embodiment, the pharmaceutically acceptable salt is the acetate salt, mesylate salt, esylate, tartarate salt, hydrogen tartarate salt, benzoate salt, phenylbutyrate salt, phosphate salt, citrate salt, ascorbate salt, mandelate salt, adipate salt, octanoate salt, the myristate salt, the succinate salt, or fumarate salt.

25

In a further embodiment, the compound has the structure:

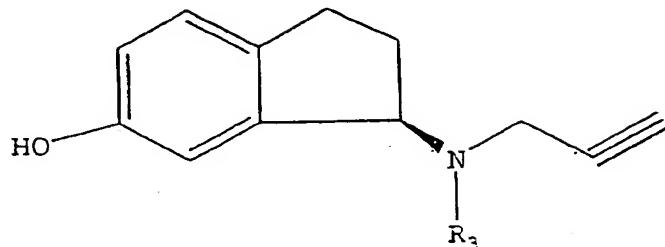
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In another embodiment, the compound has the structure:

5



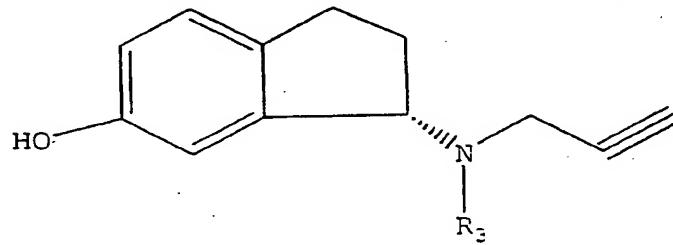
In an added embodiment, R₃ is H.

10

In yet another embodiment, R₃ is Me.

In a further embodiment, the compound has the structure:

15



20

In one embodiment, R₃ is H.

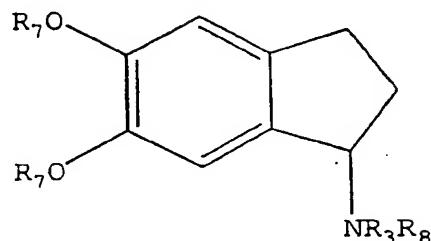
In another embodiment, R₃ is Me.

25

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The subject invention further provides a compound having the structure:

5



wherein R₇ is H, C₁ to C₆ alkyl, aryl, aralkyl or C(O)R₄,
wherein R₄ is branched or unbranched C₁ to C₆ alkyl,
10 aryl, aralkyl or NR₅R₆,

10

wherein R₅ and R₆ are each independently H, C₁ to C₆ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

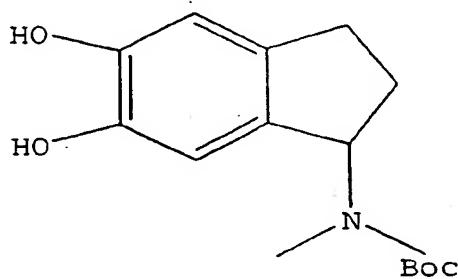
wherein R₃ is H or C₁ to C₆ alkyl;

15

wherein R₈ is H or t-butoxycarbonyl (Boc).

In one embodiment, the compound has the structure:

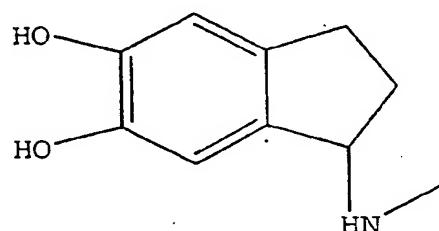
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25

In another embodiment, the compound has the structure:

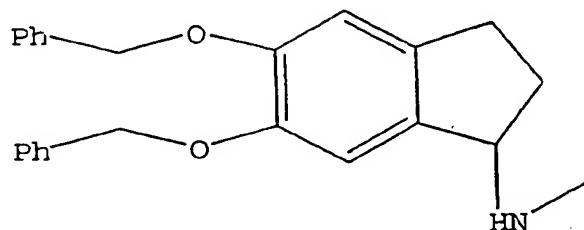
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In still another embodiment, the compound has the structure:

5

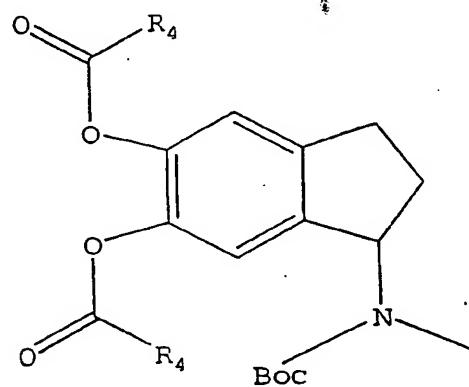


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20

In an added embodiment, the compound has the structure:

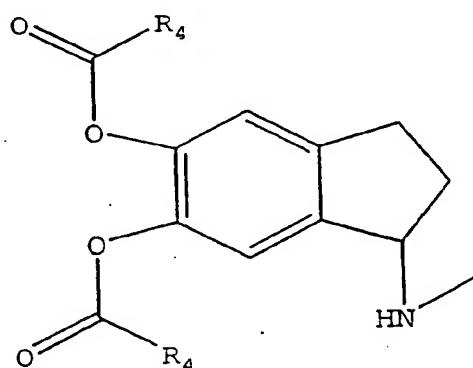


In yet another embodiment, R₄ is Ph.

In one embodiment, the compound has the structure:

25

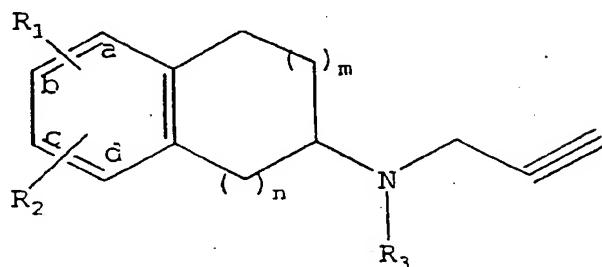
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-35-

In a further embodiment, R₄ is Ph.

The subject invention additionally provides a pharmaceutical composition comprising a compound having the structure:



wherein R₁ is OC(O)R₉ and R₂ is H,

wherein R₉ is branched or unbranched C₁ to C₆ alkyl, aryl, or aralkyl, or

15 R₁ is OC(O)R₄ and R₂ is OC(O)R₄,

wherein R₄ is branched or unbranched C₁ to C₆ alkyl, aryl, aralkyl or NR₅R₆,

20

wherein R₅ and R₆ are each independently H, C₁ to C₈ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

wherein R₃ is H or C₁ to C₆ alkyl;

wherein n is 0 or 1; and

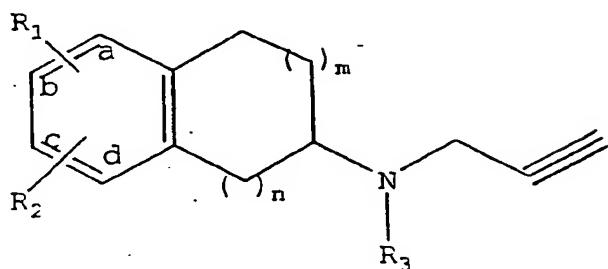
wherein m is 1 or 2,

or a pharmaceutically acceptable salt thereof.

25

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The subject invention further provides a pharmaceutical composition comprising a compound having the structure:



wherein R₂ is H or OC(O)R₄ when R₁ is attached to the "a" carbon or the "d" carbon, or
R₂ is OC(O)R₄ when R₁ is attached to the "b" carbon or the "c" carbon;

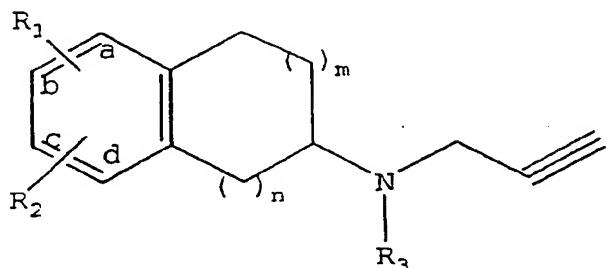
15

wherein R₄ is C₁ to C₆ branched or unbranched alkyl, aryl, aralkyl or NR₅R₆,
wherein R₅ and R₆ are each independently H, C₁ to C₈ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

20

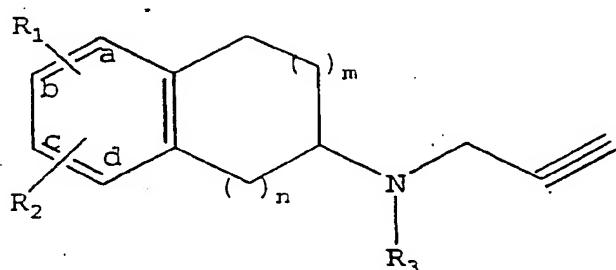
wherein n is 0 or 1, and m is 1 or 2; and
wherein R₃ is H or Me when n is 1 and m is 1, or R₃ is H or C₁ to C₆ alkyl when n is 0 or m is 2,
or a pharmaceutically acceptable salt thereof.

The subject invention also provides a pharmaceutical composition comprising a compound having the structure:



10 wherein the compound is an optically pure enantiomer;
wherein R₁ is OH;
wherein R₂ is H;
wherein R₃ is H or C₁ to C₆ alkyl;
wherein n is 0 or 1; and
15 wherein m is 1 or 2,
or a pharmaceutically acceptable salt thereof.

The subject invention also provides a method of treating a subject afflicted with a neurological disease comprising administering to the subject a compound having the structure:



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wherein R_1 is OH or $OC(O)R_4$;

wherein R_2 is H, OH or $OC(O)R_4$,

wherein R_4 is branched or unbranched C_1 to C_6 alkyl, aryl, aralkyl or NR_5R_6 ,

wherein R_5 and R_6 are each independently H, C_1 to C_8 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to C_{12} cycloalkyl, each optionally substituted;

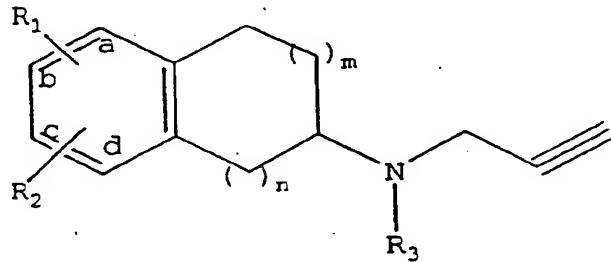
wherein R_3 is H or C_1 to C_6 alkyl;

wherein n is 0 or 1; and

wherein m is 1 or 2,

10 or a pharmaceutically acceptable salt thereof, or a prodrug which becomes the compound in the subject, so as to thereby treat the neurological disease in the subject.

15 Additionally, the subject invention provides a method of treating a subject afflicted with a neurological disease, comprising administering to the subject a compound having the structure:



20 wherein R_1 is OH or $OC(O)R_9$, and R_2 is H or $OC(O)R_4$, or both R_1 and R_2 are $OC(O)R_4$,

wherein R_9 is branched or unbranched C_1 to C_6 alkyl, aryl, or aralkyl;

wherein R_4 is branched or unbranched C_1 to C_6 alkyl, aryl, aralkyl or NR_5R_6 ,

30 wherein R_5 and R_6 are each independently H, C_1 to C_8 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to C_{12} cycloalkyl, each optionally substituted;

wherein R_3 is H or C_1 to C_6 alkyl;

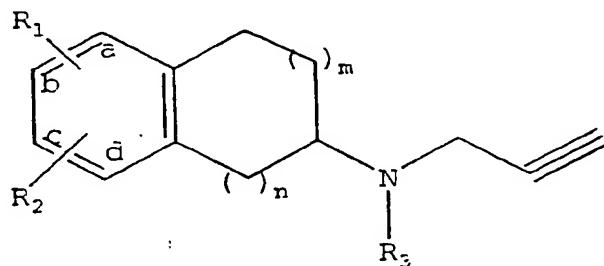
wherein n is 0 or 1; and

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wherein m is 1 or 2,
 or a pharmaceutically acceptable salt thereof, or a prodrug
 which becomes the compound in the subject, so as to thereby
 treat the neurological disease in the subject.

5 In one embodiment of the method, the compound has the structure:

10



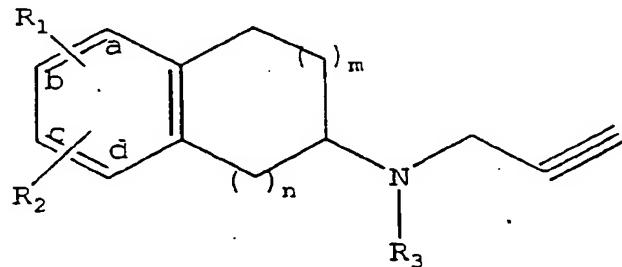
15

wherein R_1 is $OC(O)R_9$ and R_2 is H,
 wherein R_9 is branched or unbranched C_1 to C_6 alkyl,
 aryl, or aralkyl, or
 R_1 is $OC(O)R_4$ and R_2 is $OC(O)R_4$,
 wherein R_4 is branched or unbranched C_1 to C_6 alkyl,
 aryl, aralkyl or NR_5R_6 ,
 wherein R_5 and R_6 are each independently H, C_1 to
 20 C_8 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to
 C_{12} cycloalkyl, each optionally substituted;
 wherein R_3 is H or C_1 to C_6 alkyl;
 wherein n is 0 or 1; and
 wherein m is 1 or 2.

25

In another embodiment of the method, the compound has the structure:

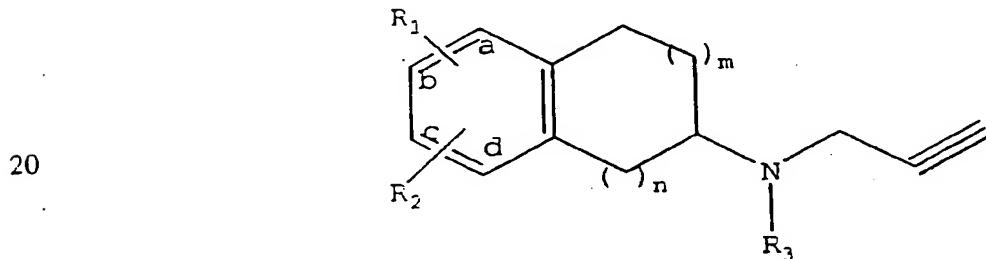
30



-40-

wherein R_1 is OH;
 wherein R_2 is H or $OC(O)R_4$ when R_1 is attached to the "a" carbon or the "d" carbon, or
 R_2 is $OC(O)R_4$ when R_1 is attached to the "b" carbon or the "c" carbon;
 wherein R_4 is C_1 to C_6 branched or unbranched alkyl, 5
 aryl, aralkyl or NR_5R_6 ,
 wherein R_5 and R_6 are each independently H, C_1 to C_6 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to C_{12} cycloalkyl; each optionally substituted;
 10 wherein R_3 is H or C_1 to C_6 alkyl;
 wherein n is 0 or 1; and
 wherein m is 1 or 2.

15 In a further embodiment of the method, the compound has the structure:



25 wherein the compound is an optically pure enantiomer;
 wherein R_1 is OH;
 wherein R_2 is H;
 wherein R_3 is H or C_1 to C_6 alkyl;
 wherein n is 0 or 1; and
 wherein m is 1 or 2.

30

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In one embodiment, the subject is human.

In a further embodiment, the administration comprises oral, parenteral, intravenous, transdermal, or rectal administration.

5 In one embodiment, the effective amount is from about 0.01 mg per day to about 100.0 mg per day.

In yet another embodiment, the effective amount is from about 0.01 mg per day to about 50.0 mg per day.

10 In still another embodiment, the effective amount is from about 0.1 mg per day to about 100.0 mg per day.

15 In an added embodiment, the effective amount is from about 0.1 mg per day to about 10.0 mg per day.

In yet another embodiment, the effective amount is from about 0.01 mg to about 100.0 mg.

20 In one embodiment, the effective amount is from about 0.01 mg to about 50.0 mg.

In a further embodiment, the effective amount is from about 0.1 mg to about 100.0 mg.

25 In another embodiment, the effective amount is from about 0.1 mg to about 10.0 mg.

30 In an additional embodiment, the neurological disease is Parkinson's disease, Alzheimer's disease, depression, epilepsy, narcolepsy, amyotrophic lateral sclerosis (ALS), memory disorders, panic, post-traumatic stress disorder (PTSD), sexual dysfunction, attention deficit and hyperactivity syndrome (ADHD), attention deficit disorder, or Tourette's syndrome. The

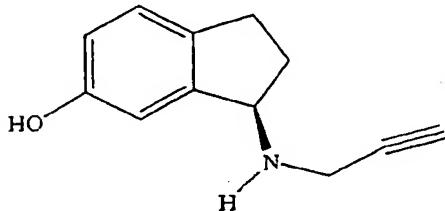
-42-

disease may also be neuropathy, hyperactive syndrome, neurotrauma, stroke, Parkinson's disease, Huntington's disease, and other dementia such as senile dementia, dementia of the vascular dementia or Lewy body dementia.

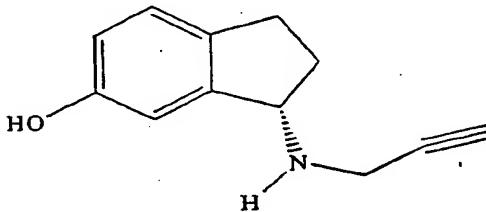
5 In still another embodiment, the neurological disease is depression.

In still another embodiment, the compound has the structure:

10



or

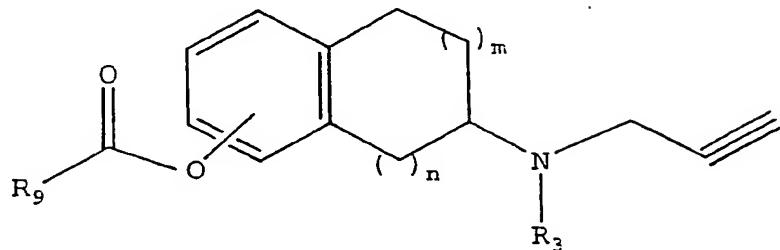


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The subject invention further provides a process for preparing a compound having the structure:

5



10

wherein n is 0 or 1, and m is 1 or 2;

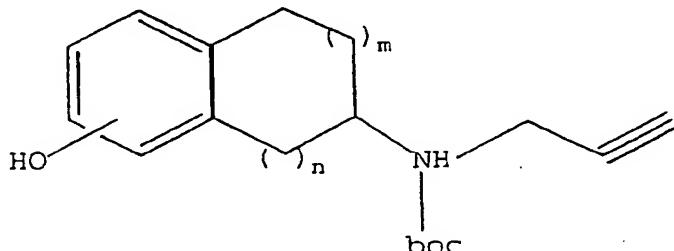
wherein R₃ is H or C₁ to C₆ alkyl; and

wherein R₉ is branched or unbranched C₁ to C₆ alkyl,

aryl, or aralkyl;

comprising the step of reacting

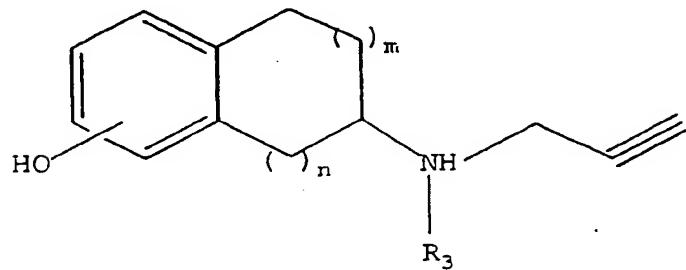
15



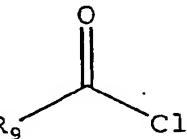
20

or

25



30

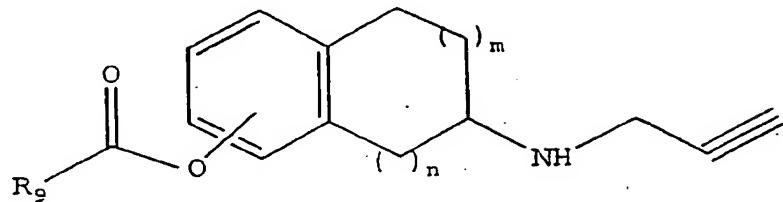


in the presence of an acid or 4-dimethylaminopyridine (DMAP) to form the compound.

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The subject invention also provides a process for preparing a compound having the structure:

5



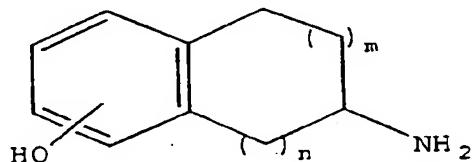
10

wherein R₉ is branched or unbranched C₁ to C₆ alkyl, aryl, or aralkyl;

which process comprises:

(a) reacting a compound having the structure:

15



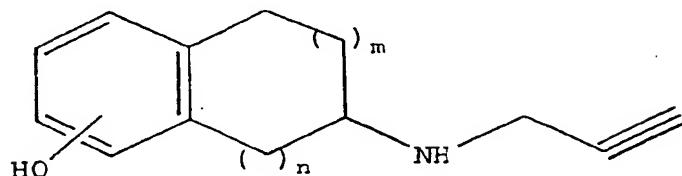
-45-

with a compound having the structure:



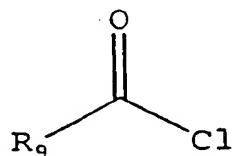
5 wherein X is a leaving group,

to produce a compound having the structure:



10 (b) reacting the compound formed in step (a) with a compound having the structure:

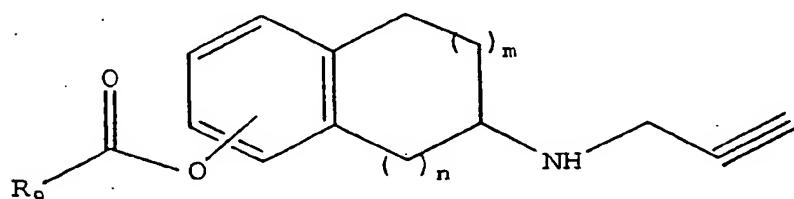
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20

in the presence of trifluoroacetic acid (TFA) and an aprotic solvent to produce a compound having the structure:

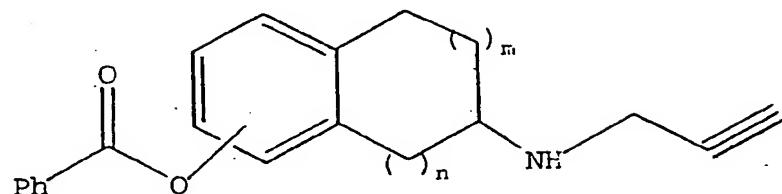
25



30 In one embodiment, the leaving group in step (a) is selected from the group consisting of a halogen and benzene sulfonate and the aprotic solvent in step (b) is CHCl₃.

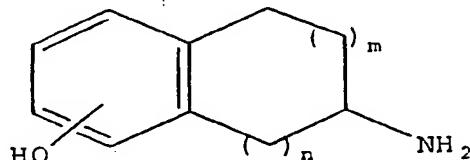
-46-

The subject invention further provides a process for preparing a compound having the structure:



which comprises:

10 (a) reacting a compound having the structure:



with a compound having the structure:

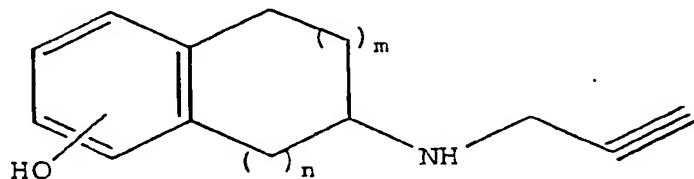
20



wherein X is a leaving group.

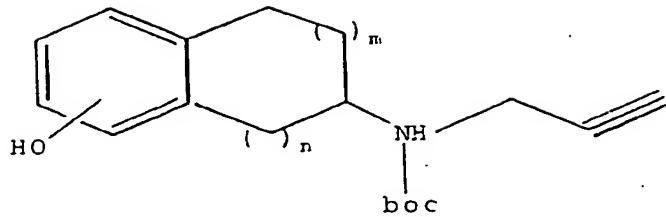
to produce a compound having the structure:

25

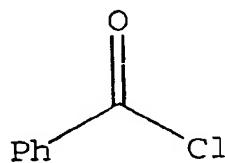


30 (b) N-protecting the compound formed in step (a) with tert-butoxycarbonyl (Boc) to produce a compound having the structure:

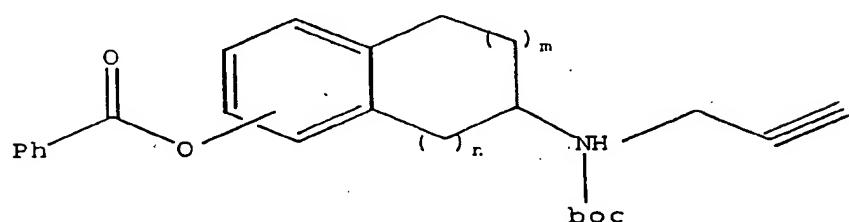
-47-



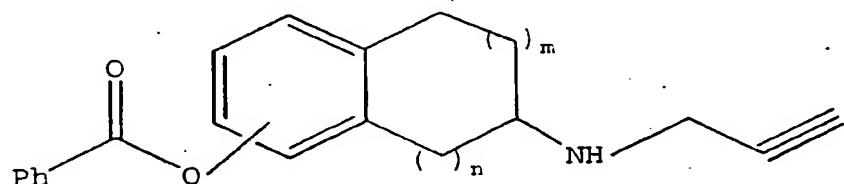
(c) reacting the compound formed in step (b) with a compound having the structure:



in the presence of 4-dimethylaminopyridine (DMAP) to produce a compound having the structure:



(d) deprotecting the compound formed in step (c) with HCl to produce a compound having the structure:



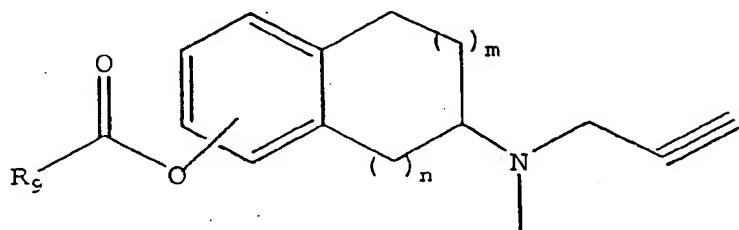
30

In one embodiment, the leaving group in step (a) is selected from the group consisting of a halogen and benzene sulfonate and the aprotic solvent in step (b) is CHCl₃.

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The subject invention additionally provides a process for preparing a compound having the structure:

5



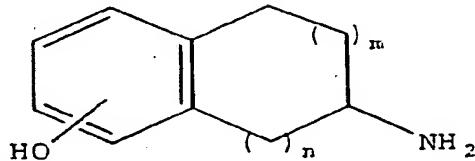
10

wherein R_9 is branched or unbranched C_1 to C_6 alkyl, aryl, or aralkyl;

which process comprises:

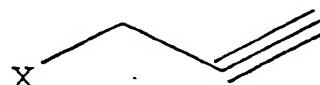
(a) reacting a compound having the structure:

15



20

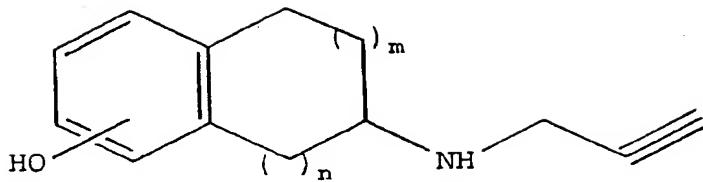
with a compound having the structure:



25

wherein X is a leaving group, to produce a compound having the structure:

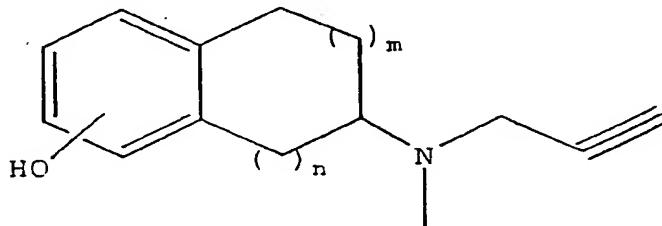
-49-



5

(b) reacting the compound formed in step (a) with NaCnBH_3 and paraformaldehyde to produce a compound having the structure:

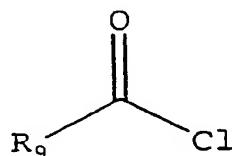
10



15

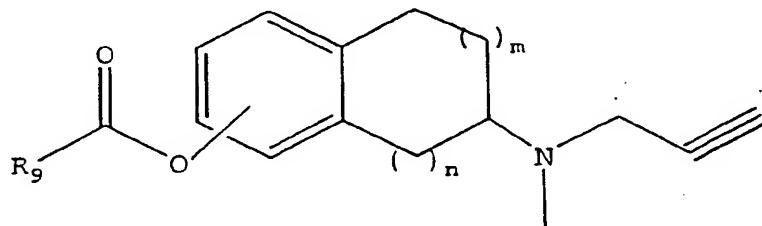
(c) reacting the compound formed in step (b) with a compound having the structure:

20



in the presence of trifluoroacetic acid (TFA) and an aprotic solvent to form a compound having the structure:

25



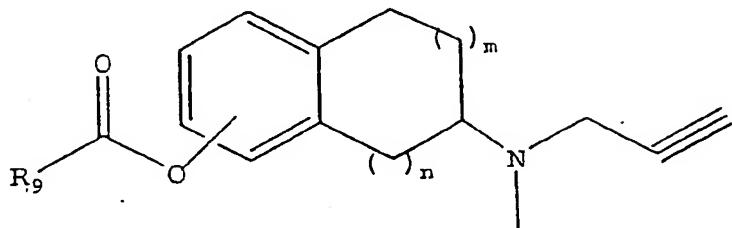
30

In one embodiment, the leaving group in step (a) is selected from the group consisting of a halogen and benzene sulfonate and the aprotic solvent in step (c) is CHCl_3 .

-50-

The subject invention provides another process for preparing a compound having the structure:

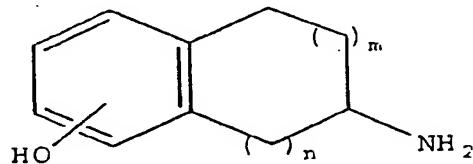
5



10 wherein R₉ is branched or unbranched C₁ to C₆ alkyl, aryl, or aralkyl;
which process comprises:

(a) reacting a compound having the structure:

15

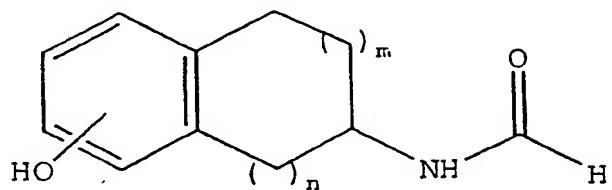


20

-51-

with ethyl formate to produce a compound having the structure:

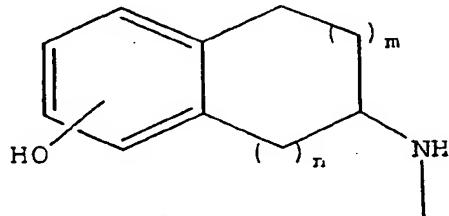
5



10

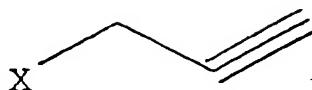
(b) reacting the compound formed in step (a) with lithium aluminum hydride to produce a compound having the structure:

15



-52-

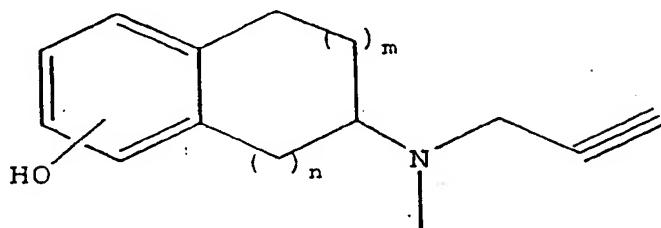
(c) reacting the compound formed in step (b) with a compound having the structure:



5

wherein X is a leaving group,
to form a compound having the structure:

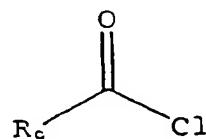
10



15

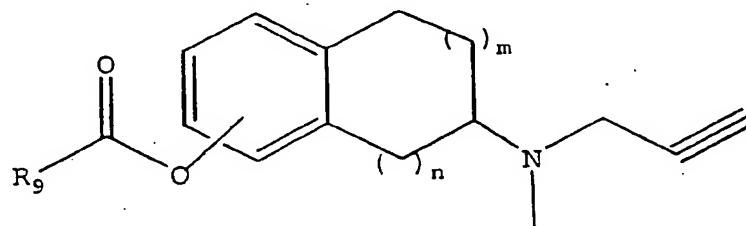
(d) reacting the compound formed in step (c) with a compound having the structure:

20



in the presence of trifluoroacetic acid (TFA) and an aprotic solvent to form a compound having the structure:

25



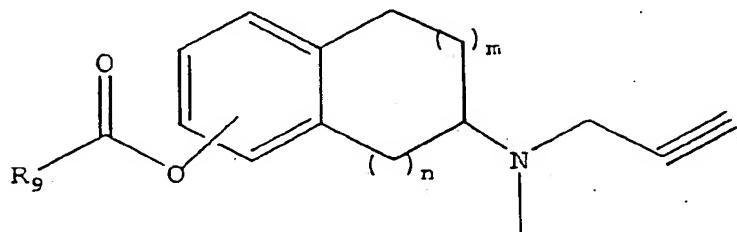
30

In one embodiment, the aprotic solvent in step (c) is CHCl3.

-53-

The subject invention provides yet another process for preparing a compound having the structure:

5



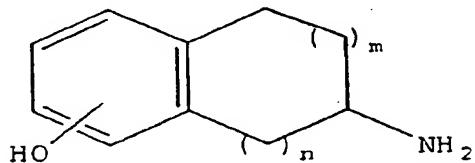
10

wherein R₉ is branched or unbranched C₁ to C₆ alkyl, aryl, or aralkyl;

which process comprises:

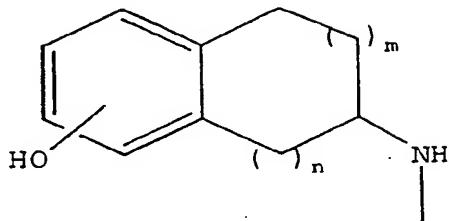
(a) reacting a compound having the structure:

15



-54-

with NaCNBH₃/paraformaldehyde to produce a compound having the structure:



(b) reacting the compound formed in step (a) with a compound having the structure:

10

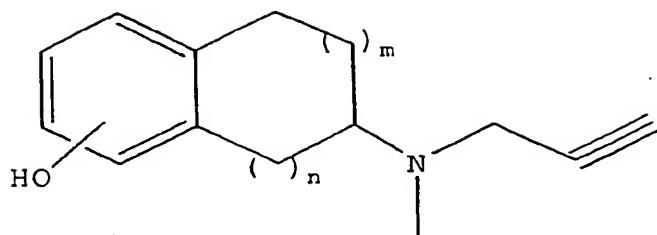


wherein X is a leaving group,

15 to form a compound having the structure:

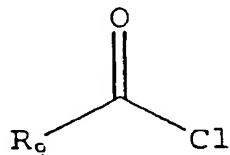
-55-

5



(c) reacting the compound formed in step (b) with a compound having the structure:

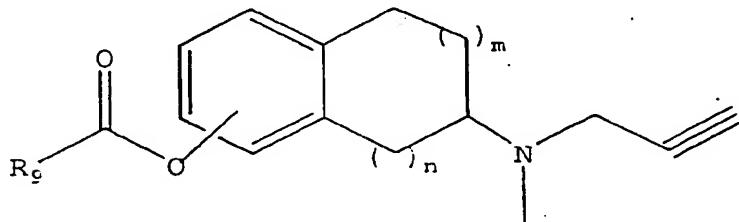
10



15

in the presence of trifluoroacetic acid (TFA) and an aprotic solvent to form a compound having the structure:

20



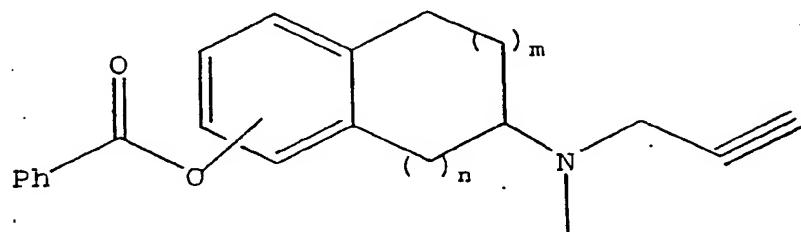
In one embodiment, the aprotic solvent in step (d) is CHCl₃.

25

-56-

Additionally, the subject invention provides a process for preparing a compound having the structure:

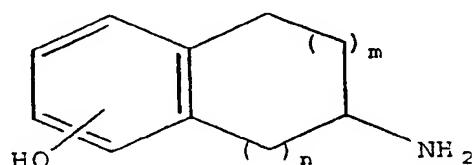
5



10

(a) reacting a compound having the structure:

15

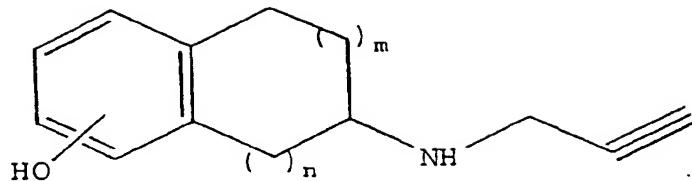


20

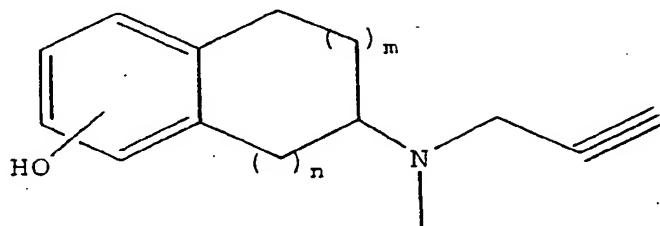


wherein X is a leaving group,
to produce a compound having the structure:

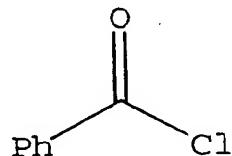
-57-



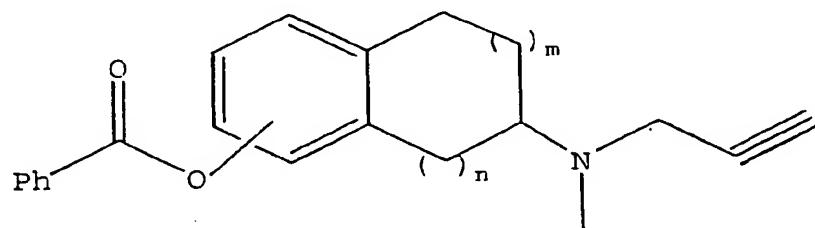
5 (b) reacting the compound formed in step (a) with NaCnBH_3 and paraformaldehyde to produce a compound having the structure:



10 (c) reacting the compound formed in step (b) with a compound having the structure:



15 20 in the presence of 4-dimethylaminopyridine (DMAP) and an aprotic solvent to form a compound having the structure:

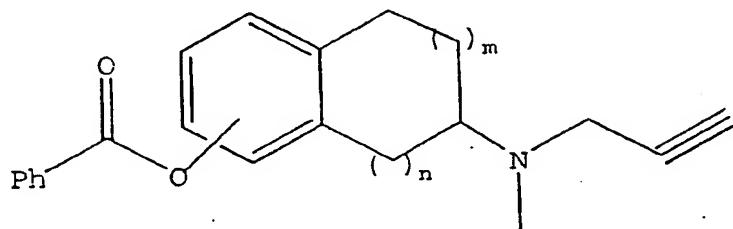


25 30 In one embodiment, the leaving group in step (a) is selected from the group consisting of a halogen and benzene sulfonate and the aprotic solvent in step (c) is CHCl_3 .

-58-

The subject invention provides another process for preparing a compound having the structure:

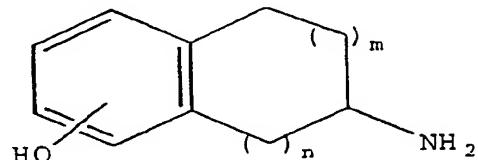
5



which comprises:

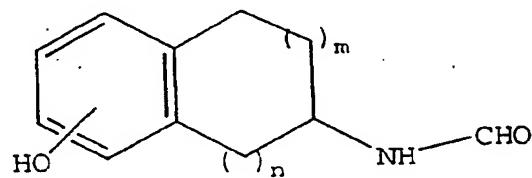
10 (a) reacting a compound having the structure:

15



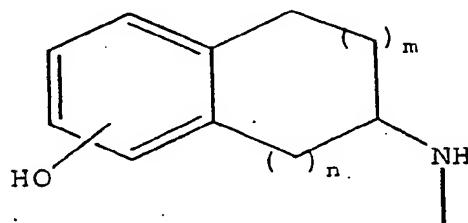
with ethyl formate to produce a compound having the structure:

20



25 (b) reacting the compound formed in step (a) with lithium aluminum hydride to produce a compound having the structure:

30



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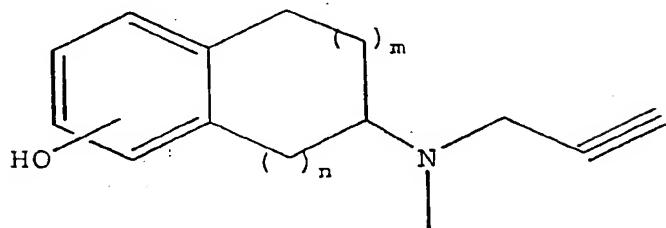
(c) reacting the compound formed in step (b) with a compound having the structure:



5

wherein X is a leaving group,
to form a compound having the structure:

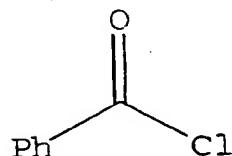
10



15

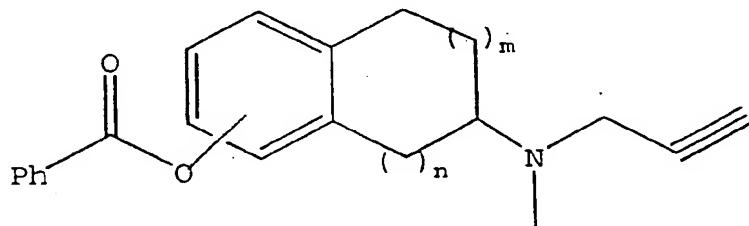
(d) reacting the compound formed in step (c) with a compound having the structure:

20



in the presence of 4-dimethylaminopyridine (DMAP) and an aprotic solvent to form a compound having the structure:

25

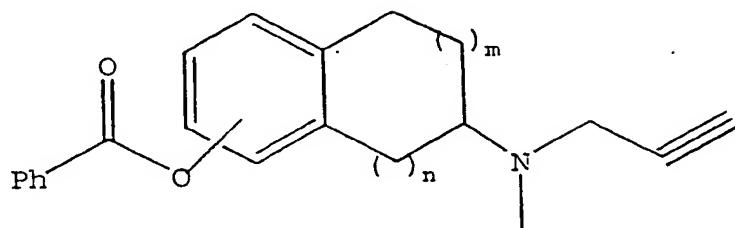


30

In one embodiment, the aprotic solvent in step (c) is $CHCl_3$.

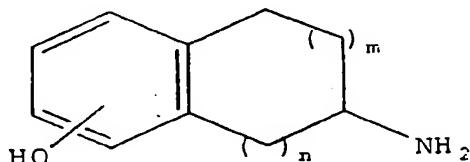
-60-

The subject invention provides yet another process for preparing a compound having the structure:



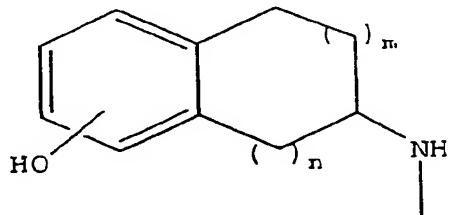
which comprises:

10 (a) reacting a compound having the structure:



with NaCnBH_3 /paraformaldehyde to produce a compound having the structure:

20



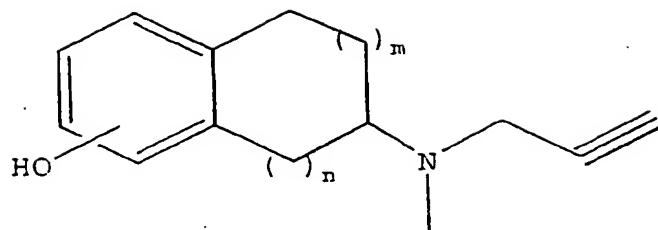
25 (b) reacting the compound formed in step (a) with a compound having the structure:

30



wherein X is a leaving group,
to form a compound having the structure:

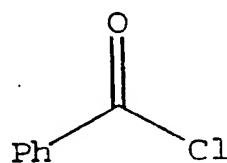
-61-



5

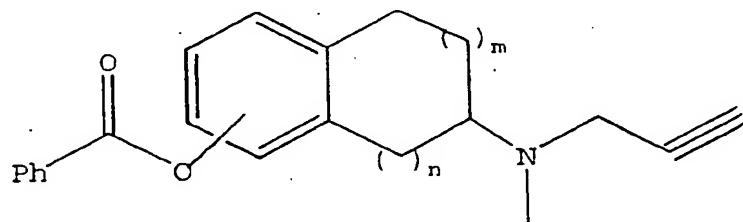
(c) reacting the compound formed in step (b) with a compound having the structure:

10



in the presence of 4-dimethylaminopyridine (DMAP) and an aprotic solvent to form a compound having the structure:

15

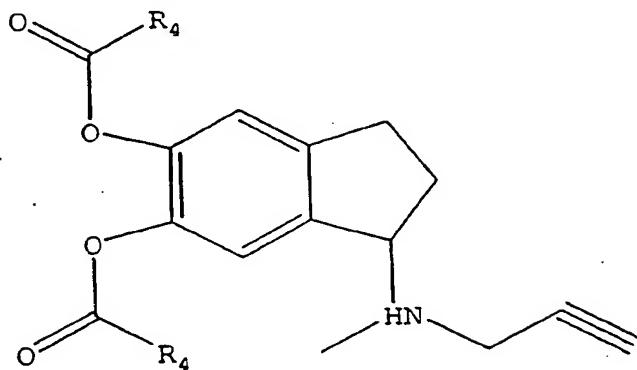


20

In one embodiment, the aprotic solvent in step (d) is CHCl3.

-62-

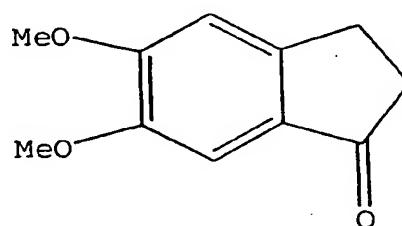
The subject invention further provides a process for preparing a compound having the structure:



which comprises:

15

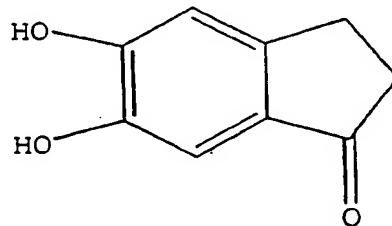
(a) reacting a compound having the structure:



25

with AlCl_3 or BBr_3 , in the presence of toluene to produce a compound having the structure:

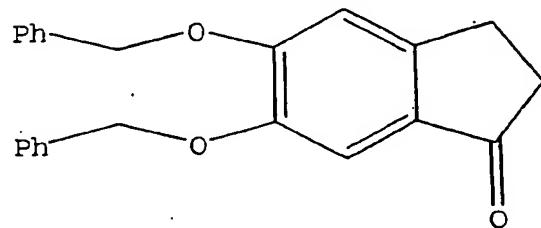
30



-63-

(b) reacting the product formed in step (a) with benzyl chloride and K_2CO_3 in the presence of dimethyl formamide (DMF) to produce a compound having the structure:

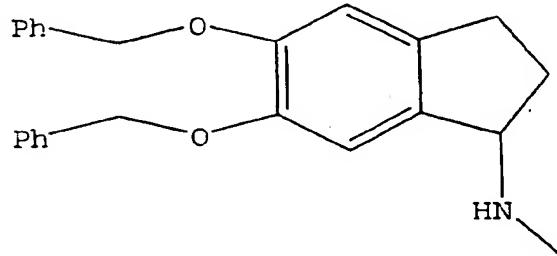
5



10

(c) reacting the product formed in step (b) with $MeNH_2 \cdot HCl$, $NaCNBH_3$, in tetrahydrofuran (THF)/MeOH to produce a compound having the structure:

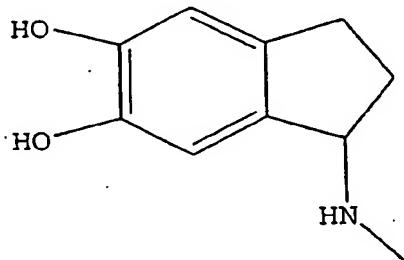
15



20

(d) reacting the product formed in step (c) with H_2 , Pd/C and MeOH to produce a compound having the structure:

25

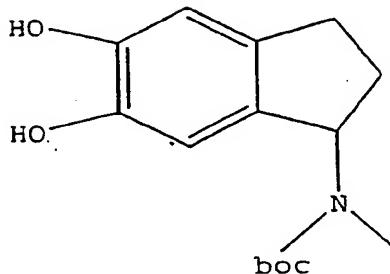


30

-64-

(e) reacting the product formed in step (d) with Boc_2O , dioxane/ H_2O and NaHCO_3 to produce a compound having the structure:

5

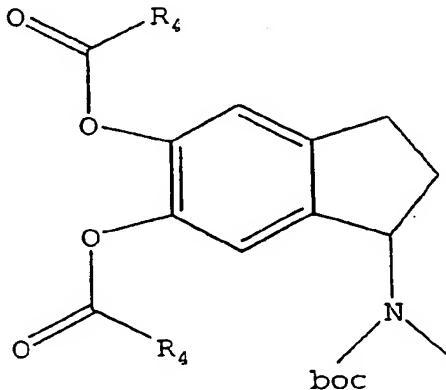


10

(f) reacting the product formed in step (e) with R_4COCl , Et_3N in CH_2Cl_2 , in the presence of 4-dimethylaminopyridine (DMAP) to produce a compound having the structure:

15

20



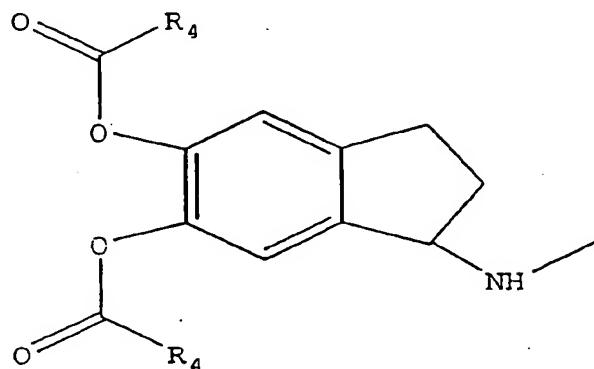
25

-65-

(g) reacting the product formed in step (f) with HCl/dioxane to produce a compound having the structure:

5

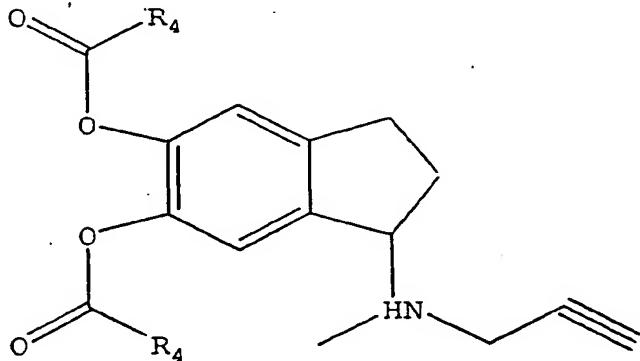
10



15

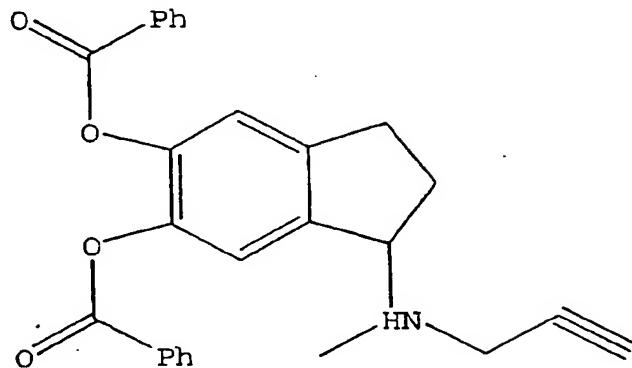
20

25



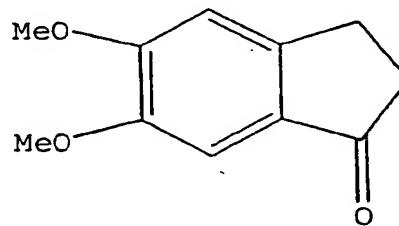
-66-

Also, the subject invention provides a process for preparing a compound having the structure:

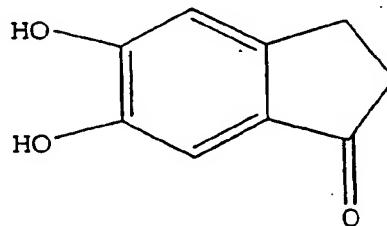


which comprises:

(a) reacting a compound having the structure:



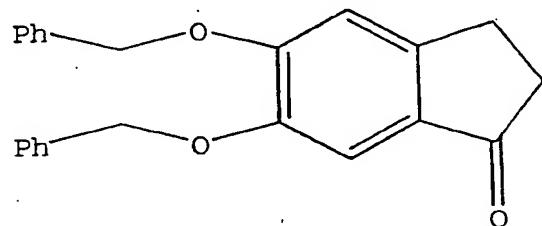
with AlCl_3 or BBr_3 in the presence of toluene to produce a compound having the structure:



-67-

(b) reacting the product formed in step (a) with benzyl chloride and K_2CO_3 in the presence of dimethyl formamide (DMF) to produce a compound having the structure:

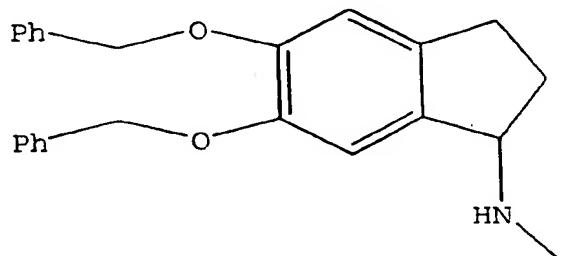
5



10

(c) reacting the product formed in step (b) with $MeNH_2 \cdot HCl$, $NaCNBH_3$ in tetrahydrofuran (THF) /MeOH to produce a compound having the structure:

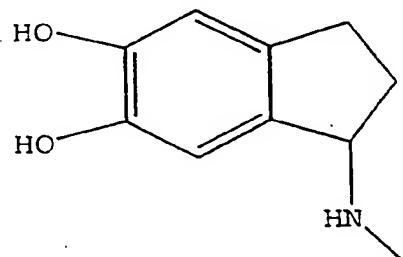
15



20

(d) reacting the product formed in step (c) with H_2 , Pd/C and MeOH to produce a compound having the structure:

25

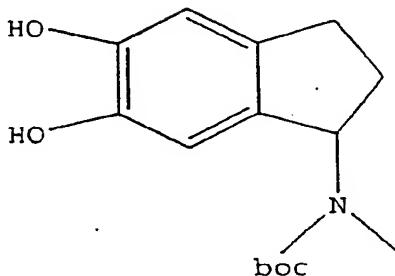


30

-68-

(e) reacting the product formed in step (d) with Boc_2O , dioxane/ H_2O and NaHCO_3 to produce a compound having the structure:

5

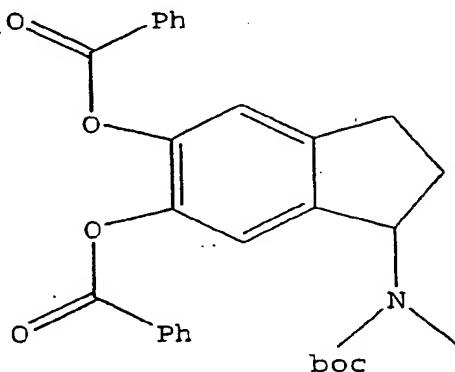


10

(f) reacting the product formed in step (e) with PhCOCl , Et_3N in CH_2Cl_2 , in the presence of 4-dimethylaminopyridine (DMAP) to produce a compound having the structure:

15

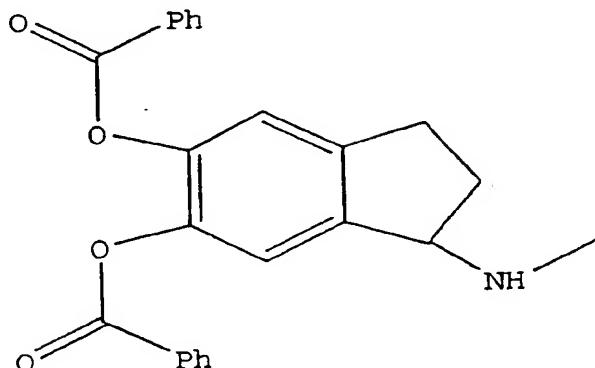
20



-69-

(g) reacting the product formed in step (f) with HCl/dioxane to produce a compound having the structure:

5

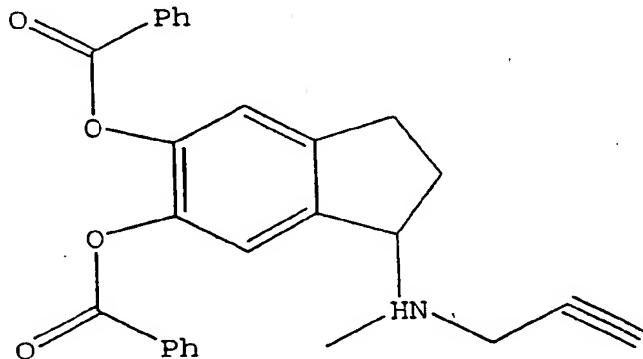


10

(h) reacting the product formed in step (g) with propargyl bromide, K_2CO_3 , in CH_3CN and then with $HCl/ether$ and $MeOH$ to produce a compound having the structure:

15

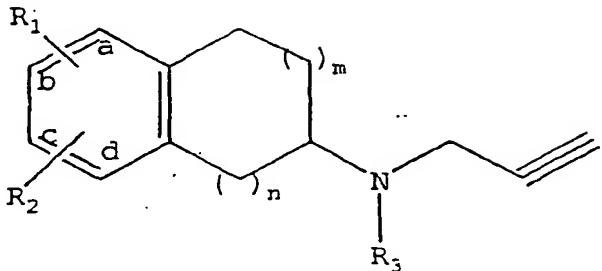
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The subject invention further provides the use of a compound or a prodrug of a compound which becomes the compound having the structure:



wherein R₁ is OH or OC(O)R₄;

10 wherein R₂ is H, OH or OC(O)R₄,

wherein R₄ is branched or unbranched C₁ to C₆ alkyl, aryl, aralkyl or NR₅R₆,

wherein R₅ and R₆ are each independently H, C₁ to C₈ alkyl, C₆ to C₁₂ aryl, C₆ to C₁₂ aralkyl or C₆ to C₁₂ cycloalkyl, each optionally substituted;

15 wherein R₃ is H or C₁ to C₆ alkyl;

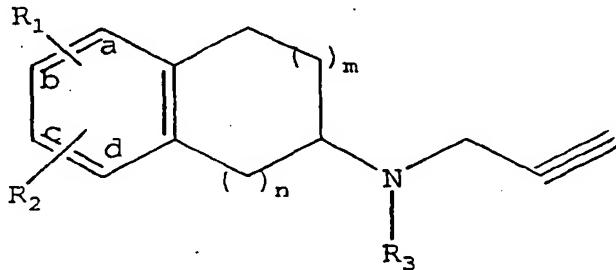
wherein n is 0 or 1; and

wherein m is 1 or 2,

or a pharmaceutically acceptable salt thereof,

20 for the manufacture of a medicament for treating a subject afflicted with a neurological disease, wherein the compound is to be periodically administered to the subject in a therapeutically effective dose.

25 The subject invention also provides the use of a compound or a prodrug of a compound which becomes the compound having the structure:



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wherein R_1 is OH or $OC(O)R_9$, and

wherein R_9 is branched or unbranched C_1 to C_6 alkyl, aryl, or aralkyl;

5 R_2 is H or $OC(O)R_4$, or both R_1 and R_2 are $OC(O)R_4$,

wherein R_4 is branched or unbranched C_1 to C_6 alkyl, aryl, aralkyl or NR_5R_6 ,

wherein R_5 and R_6 are each independently H, C_1 to C_6 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to C_{12} cycloalkyl, each optionally substituted;

wherein R_3 is H or C_1 to C_6 alkyl;

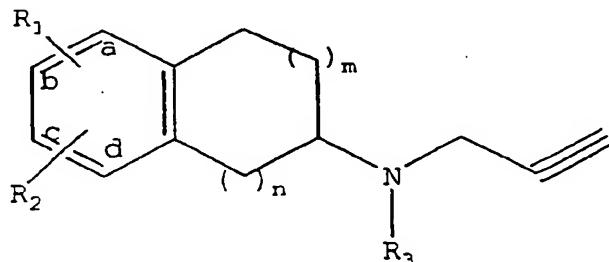
10 wherein n is 0 or 1; and

wherein m is 1 or 2,

or a pharmaceutically acceptable salt thereof, for the manufacture of a medicament for treating neurological disease in a subject, wherein the compound is to be 15 periodically administered to the subject in a therapeutically effective dose.

In one embodiment of the use, the compound has the structure:

20



25

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wherein R_1 is $OC(O)R_9$, and R_2 is H,

wherein R_9 is branched or unbranched C_1 to C_6 alkyl,
aryl, or aralkyl, or

R_1 is $OC(O)R_4$ and R_2 is $OC(O)R_4$,

wherein R_4 is branched or unbranched C_1 to C_6 alkyl,
aryl, aralkyl or NR_5R_6 ,

5 wherein R_5 and R_6 are each independently H, C_1 to
 C_6 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to
 C_{12} cycloalkyl, each optionally substituted;

wherein R_2 is H or C_1 to C_6 alkyl;

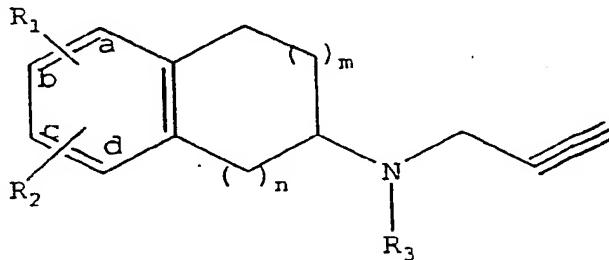
10 wherein n is 0 or 1; and

wherein m is 1 or 2.

In another embodiment of the use, the compound has the structure:

15

20



wherein R_1 is OH;

wherein R_2 is H or $OC(O)R_4$ when R_1 is attached to the "a"
carbon or the "d" carbon, or

25 R_2 is $OC(O)R_4$ when R_1 is attached to the "b" carbon or
the "c" carbon;

wherein R_4 is C_1 to C_6 branched or unbranched alkyl,
aryl, aralkyl or NR_5R_6 ,

30 wherein R_5 and R_6 are each independently H, C_1 to
 C_6 alkyl, C_6 to C_{12} aryl, C_6 to C_{12} aralkyl or C_6 to
 C_{12} cycloalkyl, each optionally substituted;

wherein R_3 is H or C_1 to C_6 alkyl;

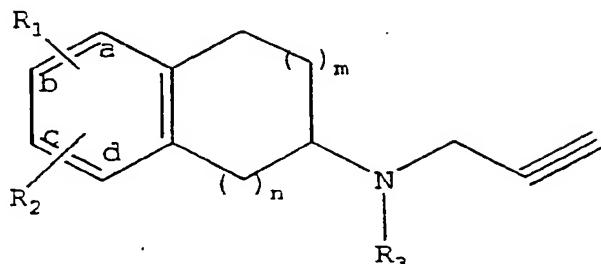
wherein n is 0 or 1; and

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wherein m is 1 or 2.

In an additional embodiment of the use, the compound has the structure:

5



10

wherein the compound is an optically pure enantiomer;

wherein R1 is OH;

wherein R2 is H;

15 wherein R3 is H or C1 to C6 alkyl;

wherein n is 0 or 1; and

wherein m is 1 or 2.

In a further embodiment of the use, the subject is human.

20

In yet another embodiment of the use, the medicament is formulated for oral, parenteral, intravenous, transdermal, or rectal administration.

25

In an embodiment of the use, the therapeutically effective amount is from about 0.01 mg per day to about 50.0 mg per day.

In an added embodiment of the use, the therapeutically effective amount is from about 0.1 mg per day to about 100.0 mg per day.

30

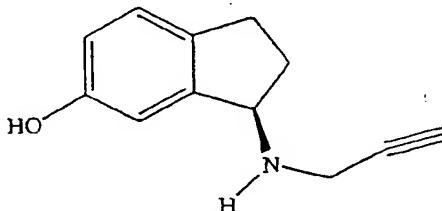
In still another embodiment of the use, the therapeutically effective amount is from about 0.1 mg per day to about 10.0 mg per day.

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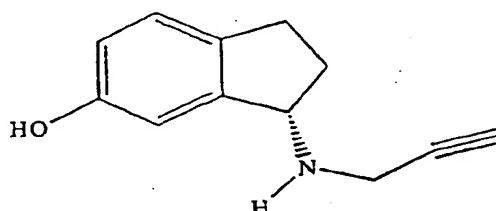
In an embodiment of the use, the neurological disease is Parkinson's disease, Alzheimer's disease, depression, epilepsy, narcolepsy, amyotrophic lateral sclerosis (ALS), memory disorders, panic, post-traumatic stress disorder (PTSD), sexual dysfunction, attention deficit and hyperactivity syndrome (ADHD), attention deficit disorder, or Tourette's syndrome.

In a further embodiment of the use, the neurological disease is depression. In one embodiment, the compound has the structure:

10



or



15

The subject invention thus discloses various derivatives and isomers of hydroxylated propargylamino indan and tetralin which have surprisingly varied potency and selectivity for MAO inhibition. The subject invention also provides modifications of the hydroxy compounds which have surprisingly varied MAO inhibitory properties depending upon the substitution pattern, however, the hydroxy compound is always a more potent inhibitor than the modified version. Thus, the modified version may be considered a prodrug of the more active hydroxy compound into which it will be metabolized *in vivo*.

In one embodiment of the invention, the prodrug compound is a carboxylic acid ester of the hydroxy compound. In another embodiment, the parent is a carbamate derivative of the hydroxy compound.

As discussed above, carbamate propargylamino indans and

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tetalins have been reported in PCT International Application No. PCT/US97/24155 as both MAO inhibitors and AchE inhibitors. However, it is a further embodiment of this invention that such a prodrug compound will not be a potent inhibitor of AchE ($IC_{50} > 500$ micromolar), and the IC_{50} for MAO-A inhibition of the 5 corresponding hydroxy metabolite be at least 100 times more potent than the prodrug.

In one embodiment, the compounds are dihydroxy derivatives of propargylamino indan or tetralin. These derivatives are 10 expected to be antioxidants, as well as MAO inhibitors. In another embodiment, the subject invention provides ester prodrugs.

Thus, the subject invention provides esters or carbamates of 15 propargylamino indanols, propargylamino indandiols, propargylamino tetralinols or propargylamino tetralindiols, and may be prepared by methods of esterification or carbamoylation 20 of hydroxy compounds. Ester derivatives (Figure 1) when R_2 equals hydrogen were prepared by reacting the propargylamino indanols with acyl chlorides in the presence of a strong organic acid such as trifluoroacetic acid or an acylation catalyst such as 4-dimethylaminopyridine (DMAP), with or without an inert 25 organic solvent such as chloroform. Compounds when R_2 equals hydrogen were prepared either by direct acylation as described above, or by first N-protecting the amine moiety, e.g., by a 30 tert-butoxycarbonyl (Boc) group, followed by acylation as above, and finally removing the protecting group. The preparation of compounds of the subject invention which are carbamates is described in PCT/US97/24155.

30

Propargylamino indanols may be prepared by reacting amino indanols with propargyl bromide in a polar organic solvent such as N,N-dimethylacetamide or acetonitrile in the presence of a base such as potassium carbonate. N-Methyl, N-propargylamino

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indanols may be prepared by reductive alkylation of propargylamino indanols by methods known to those skilled in the art, e.g., with NaCNBH₃ and paraformaldehyde. Alternatively, N-methyl,N-propargylamino indanols were prepared by first 5 methylating amino indanols either by NaCNBH₃/paraformaldehyde or by ethyl formate followed by LiAlH₄ reduction, and then reacting the N-methylamino indanols thus obtained with propargyl bromide as described above.

10 The N-propargyl derivatives of, *inter alia*, 3-amino-indan-4-ol, 1-amino-indan-4-ol, 3-amino-indan-5-ol and 7-amino-5,6,7,8-tetrahydro-naphthalen-2-ol were prepared.

15 Compounds of the subject invention with both R₁ and R₂ equal to OCOR₄ (see Figure 2, compound numbered 9) were prepared by propargylation of 5,6-di-O-benzoyl-1-methylamino-1-indan (Figure 2, compound numbered 8), as described above. 5,6-Di-O-benzoyl-1-methylamino-1-indan (Figure 2, compound numbered 8) was prepared from 5,6-bis-benzyloxy-1-indanone 3 as follows:

- 20 1) reductive amination of the compound numbered 3 in Figure 2 as described above gave 5,6-bis-benzyloxy-1-indanyl)methylamine (Figure 2, compound numbered 4);
- 25 2) the compound numbered 4 in Figure 2 was debenzylated by catalytic hydrogenation and protected by the Boc group to give N-Boc-1-methylamino-indan-5,6-diol (Figure 2, compound numbered 6); and
- 30 3) Compound 6 in Figure 2 was esterified as described above and the protecting group removed as previously described to give 5,6-di-O-benzoyl-1-methylamino-1-indan (Figure 2, compound numbered 8).

30

The diester tetralin derivative numbered 12 (Figure 3) was prepared by esterification of the dihydroxy tetralin numbered 11 (Figure 3).

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Table 1. Chemical Data

cmpd #	ster	R ₂	R ₁	R ₁ pos	R ₃	n	m	mp	formula	yield (%)
100*	S	H	OH	6	H	0	1	175-7	C ₁₃ H ₁₇ NO ₄ S	45
101*	R	H	OH	6	H	0	1	173-5	C ₁₃ H ₁₇ NO ₄ S	42
102	S	H	OCOMe	6	H	0	1	138-40	C ₁₄ H ₁₆ CINO ₂	46
103	R	H	OCOMe	6	H	0	1	156-8	C ₁₄ H ₁₆ CINO ₂	77
104	S	H	OCOnBu	6	H	0	1	126-8	C ₁₇ H ₂₂ CINO ₂	67
105	R	H	OCOnBu	6	H	0	1	128-30	C ₁₇ H ₂₂ CINO ₂	46
106	S	H	OCOnBu	6	H	0	1	149-50	C ₁₇ H ₂₂ CINO ₂	37
107	R	H	OCOnBu	6	H	0	1	155-7	C ₁₇ H ₂₂ CINO ₂	85
108	S	H	OCOCH ₂ Ph	6	H	0	1	144-5	C ₂₀ H ₂₀ CINO ₂	22
109	R	H	OCOCH ₂ Ph	6	H	0	1	145-7	C ₂₀ H ₂₀ CINO ₂	52
110	S	H	OCOPh	6	H	0	1	202-4	C ₁₉ H ₁₈ CINO ₂	18
111	R	H	OCOPh	6	H	0	1	210-11	C ₁₉ H ₁₈ CINO ₂	61
112	rac	H	OH	6	Me	0	1	210-11	C ₁₅ H ₁₆ CINO	70
113	S	H	OH	6	Me	0	1	82-4	C ₁₃ H ₁₆ CINO	72
114	R	H	OH	6	Me	0	1	71-2	C ₁₃ H ₁₆ CINO	78
115	S	H	OCOMe	6	Me	0	1	168-70	C ₁₅ H ₁₈ CINO ₂	95
116	R	H	OCOMe	6	Me	0	1	168-70	C ₁₅ H ₁₈ CINO ₂	93
117	rac	H	OH	4	Me	0	1	160-62	C ₁₃ H ₁₆ NCIO	89
118	rac	H	OH	7	Me	0	1	83-5	C ₁₃ H ₁₆ NCIO	53
119	rac	H	OCOMe	4	Me	0	1	148-50	C ₁₅ H ₁₈ CINO ₂	72
120	rac	H	OCOPh	4	Me	0	1	176-8	C ₂₀ H ₂₀ CINO ₂	59
121	rac	H	OCOPh(OMe) ₂	4	Me	0	1	183-5	C ₂₂ H ₂₄ CINO ₄	39
122	rac	H	OCOPh	7	Me	0	1	185-7	C ₂₀ H ₂₀ CINO ₂	45
123	rac	H	OH	7	Me	1	1	220-1	C ₁₄ H ₁₈ NCIO	66
124	rac	H	OCOPh	7	Me	1	1	104-6	C ₂₁ H ₂₂ CINO ₂	71
125	S	H	OCOnBu	6	Me	0	1	78-80	C ₁₈ H ₂₄ CINO ₂	73
126	R	H	OCOnBu	6	Me	0	1	96-8	C ₁₈ H ₂₄ CINO ₂	72
127	S	H	OCOPh	6	Me	0	1	73-5	C ₂₀ H ₂₀ CINO ₂	52
128	R	H	OCOPh	6	Me	0	1	82-4	C ₂₀ H ₂₀ CINO ₂	56

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Table 1. Chemical Data cont.

129	S	H	OCOtBu	6	Me	0	1	153-5	C ₁₈ H ₂₄ CINO ₂	73
130	R	H	OCOtBu	6	Me	0	1	155-7	C ₁₈ H ₂₄ CINO ₂	78
131	S	H	OCOPh(Me)	6	Me	0	1	**	C ₂₁ H ₂₂ CINO ₂	51
132	R	H	OCOPh(Me)	6	Me	0	1	82-4	C ₂₁ H ₂₂ CINO ₂	46
133	S	H	OCOPh(OMe) ₂	6	Me	0	1	118-20	C ₂₂ H ₂₄ CINO ₂	58
134	R	H	OCOPh(OMe) ₂	6	Me	0	1	73-5	C ₂₂ H ₂₄ CINO ₂	68
135	rac	H	OH	7	H	0	1	166-8	C ₁₂ H ₁₄ CINO	35
136	rac	H	OH	4	H	0	1	196-8	C ₁₂ H ₁₄ CINO	66
137	rac	OCOPh (5-pos)	OCOPh	6	Me	0	1	114-5	C ₂₇ H ₂₄ CINO ₄	59
138	rac	OCOPh (6-pos)	OCOPh	7	Me	1	1	180-2	C ₂₈ H ₂₆ CINO ₄	58

ster = stereochemistry

pos = position

mesylate salts

** wide range, hygroscopic

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Table 2. ^1H -NMR Data ($\text{R}_1 = \text{R}_3 = \text{H}$) (300 MHz, dimethyl sulfoxide (DMSO)-d₆)

Cmpd #	Ph	indan			Pg		R ₄	NH ₂
		C3-H	C2-H	C1-H	CH ₂	CH		
5	102	7.52(d)						
		7.35(d)	4.79(m)	2.43(m)	2.83(m)	3.88(m)	3.71(m)	2.27 (Me,s)
	103	7.10(dd)		2.28(m)	3.12(m)			10.2 (br s)
	104	7.48(d)						
		7.36(d)	4.79(m)	2.45(m)	2.85(m)	3.90(m)	3.72(m)	1.30 (tBu,s)
	105	7.07(dd)		2.27(m)	3.12(m)			10.15 (br s)
10	108	7.48(d)						
		7.36(d)	4.80(m)	2.45(m)	2.85(m)	3.91(m)	3.72(m)	7.38(m,1H)
	109	7.07(dd)		2.28(m)	3.13(m)			7.33(m,4H)
								3.99(CH ₂ ,s)
15	106	7.48(d)						2.57(t,2H)
		7.35(d)	4.79(m)	2.45(m)	2.85(m)	3.90(m)	3.71(m)	1.61(m,2H)
	107	7.08(dd)		2.26(m)	3.11(m)			1.38(m,2H) 0.91(t,3H)
20	110	7.67(d)						
		7.42(d)	4.83(m)	2.46(m)	2.86(m)	3.93(m)	3.72(m)	8.13(d,2H)
	111	7.28(dd)		2.30(m)	3.16(m)			7.76(t,1H) 7.61(t,2H)

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Table 3. $^1\text{H-NMR}$ Data ($\text{R}_1 = \text{H}$, $\text{R}_2 = \text{Me}$) (300 MHz, D_2O)

Cmpd #	Ph	Indan			Propargyl		R ₄	N-Me
		C3-H	C2-H	C1-H	CH ₂	CH		
5	116	7.50(d) 7.35(d)	5.22(m)	2.46(m)	3.07(m)	4.05(m)	3.15(m)	2.37(Me,s)
	115	7.25(dd)		2.60(m)	3.17(m)			2.83(s)
	126	7.50(d) 7.33(d)	5.23(m)	2.49(m)	3.07(m)	4.05(m)	3.17(m)	2.69(t,2H) 1.73(m,2H)
	125	7.22(dd)		2.62(m)	3.17(m)			2.82(s) 1.44(m,2H) 0.97(t,3H)
	128	7.50(d) 7.40(d)	5.17(m)	2.57(m)	3.06(m)	4.00(m)	3.15(m)	8.11(dd,2H) 7.74(dt,1H)
	127	7.29(dd)		2.47(m)	3.17(m)			2.81(s) 7.57(t,2H)
10	129	7.49(d) 7.28(d)	5.20(m)	2.60(m)	3.05(m)	4.03(m)	3.17(m)	1.37(s,9H)
	130	7.21(dd)		2.45(m)	3.16(m)			2.81(s)
	131	7.90(d,1H) 7.44(t,1H)	5.02(m)	2.50(m)	3.08(m)	3.93(m)	3.14(m)	For Ar H's, see under Ph.
	132	7.36(m,2H) 7.21(m,2H) 7.08 (dd,1H)		2.40(m)	2.95(m)			2.72(s) 2.43(s,Me)
15	133	7.5-7.1 (m,4H)	5.05	2.50(m)	3.08(m)	3.92(m)	3.16(m)	For Ar H's, see under Ph.
	134	6.74(dd,2H)	(br d)	2.41(m)	2.95(m)			2.73(s) 3.84 (s,6H, OMe)

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